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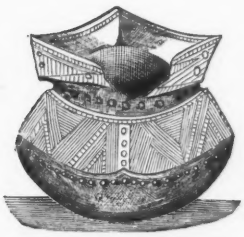
VOLUME VI.



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ERRATA.

Vol. V.— Page 564, line 22, for *ventral* read *dorsal*; line 24, dele *and Donacia*. Page 565, line 8, for *Donacia* read *Telephorus*; line 6 from bottom, for *They are* read *Attelabus is*. Page 566, line 1 from bottom, after *white* insert *Telephorus*. Page 745, line 29, for *Raphidophora maculata* read *Ceuthophilus maculatus*; line 31, for *Raphidophora subterranea* read *Hadeneeus cavernarum*. Page 746, under cut, for *Raphidophora subterranea* read *Hadeneeus cavernarum*. Page 759, line 18, for *Raphidophora* read *Ceuthophilus*; line 23, for *R* read *H*; and for *stygia* read *Ceuthophilus stygius*; line 35, for *R. stygia* read *Ceuthophilus stygius*.

Vol. VI.— Page 45, line 9 from bottom, for TENNIFOLIUM read TENUIFOLIUM. Page 72, line 10, for *Denver 2105 feet above the sea* read *5105 feet*. Page 136, line 3, for *equivalency* read *equivalence*. Page 138, line 4 of note, for *applications* read *appliances*. Page 140, line 24, for *advertency* read *inadvertency*. Page 141, line 3 from bottom, for *from* read *for*. Page 176, head line, for GEOLOGY read ZOOLOGY. Page 178, head line, for ZOOLOGY read GEOLOGY; line 18, for *Chantauqua* read *Chautauqua*. Page 187, line 18, insert *S.* before *Beale*. Page 192, line 4 from bottom, for 321 read 317. Page 237, line 9 from bottom, for *Danus* read *Danaus*. Pages 286–289, for *Urella* read *Urella*. Page 289, line 30, for *glaucoma* read *glaucoma*. Page 350, line 3, for *Leucosticta griseinucha* read *L. tephrocotis*. Page 327, place § before last note. Pages 327 and 329, in the last square of the upper row insert a *comma* after *binocular*. Page 374, line 25, for *Dongall* read *Dougall*. Page 515, line 15, for *W. Doubleday* read *Mr. Doubleday*; last line but one, for *eren unite their faces* read *ever unite their forces*. Page 516, line 6, for *enclosed* read *eclosed*; line 9, for *there* read *then*; line 16, for *trace* read *traces*.

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CONCERNING DEEP-SEA DREDGINGS.

BY PROF. L. AGASSIZ.*

My Dear Friend:—On the point of starting for the Deep-Sea Dredging expedition, for which you have so fully provided, and which I trust may prove to be one of the best rewards for your devotion to the interests of the Coast Survey, I am desirous to leave in your hands a document which may be very compromising for me, but which I nevertheless am determined to write in the hope of showing within what limits natural history has advanced toward that point of maturity when science may anticipate the discovery of facts.

If there is, as I believe to be the case, a plan according to which the affinities among animals and the order of their succession in time were determined from the beginning, and if that plan is reflected in the mode of growth, and in the geographical distribution of all living beings; or, in other words, if this world of ours is the work of intelligence, and not merely the product of force and matter, the human mind, as a part of the whole, should so chime with it, that, from what is known, it may reach the unknown; and if this be so the amount of information thus far gathered should, within the limits of errors which the imperfection of our knowledge renders unavoidable, be sufficient to foretell what

*Communicated by Prof. Peirce from advance sheets of Bulletin of the Museum of Comparative Zoology. No. 3. A Letter concerning Deep-Sea Dredgings, addressed to Professor Benjamin Peirce, Superintendent United States Coast Survey, by Louis Agassiz. Cambridge, Mass., December 2, 1871.

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we are likely to find in the deepest abysses of the sea, from which thus far nothing has been secured.

I will not undertake to lay down the line of argument upon which I base my statement, beyond what is suggested in the few words preceding, namely, that there is a correlation between the gradation of animals in the complication of their structure, their order of succession in geological times, their mode of development from the egg, and their geographical distribution upon the surface of the globe. If that be so, and if the animal world designed from the beginning has been the motive for the physical changes which our globe has undergone, and if, as I also believe to be the case, these changes have not been the cause of the diversity now observed among organized beings, then we may expect from the greater depth of the ocean representatives resembling those types of animals which were prominent in earlier geological periods, or bear a closer resemblance to younger stages of the higher members of the same types, or to the lower forms which take their place nowadays. And to leave no doubt that I have a distinct perception of what I may anticipate, I make the following specific statement.

It lies in the very nature of these animals that, among vertebrates, neither Mammalia nor Birds can exist in deep waters, and if any Reptiles exist there, it could only be such as are related to the extinct types of the Jurassic periods, the Ichthyosauri, Plesiosauri, and Pterodactyles, but even of these there is very little probability that any of their representatives are still alive. Among the fishes, however, I expect to discover some marine representatives of the order of Ganoids of both the principal types known from the secondary zoological period, such as Lepidoids, Sauroids, Pycnodonts, Cœlacanthes, Amioids, and Glyptolepis-like species may even be looked for. Among Selachians some new representatives of Cestraciontes or Hybodontes may be forthcoming, connecting the latter more closely to Odontaspis. I also look forward to finding species allied to Corax, or connecting this genus with Notidanus, perhaps also Jurassic-like forms. Among Chimæroids we may expect some new genera more closely related to the extinct types of that family than those now living. Among ordinary fishes I take it for granted that Beryx genera may be added to our list, approaching perhaps Acanus or rather Sphenocephalus; also types allied to Istieus, to Anenchelum, and to Os-

meroides, Elops, and Argentina. Dercetis and Blochius may also come up. Species of all classes of the animal kingdom which have been very rarely met with by fishermen and naturalists are likely to be found in the deepest waters, in which neither hooks nor nets are generally lowered. Nothing is known concerning the greatest depth at which fishes may live. Upon this point I hope to obtain positive data.

The Mollusks will, no doubt, afford a rich harvest of novelties, among which some may be of the deepest zoological interest. It stands to reason that a variety of Nautiloid Cephalopods may be discovered when Nautilus proper and Spirula are so rarely found alive, and among new forms there may be those combining characters of Argonauts with features of Nautilus; some may even be coiled up like Turrilites. Belemnitic Squids would appear natural. Among Gasteropods we may look for high spired Natica-like types, for representatives of Acteonella, Avellana, and the like; for small Volutoids of the Tertiary and Cretaceous types, for Rostellarias, even for Nerineas, and more particularly for forms intermediate between Firulea and Cyprea. Among Acephala I would expect a variety of Myacea approaching those described in my monographs of that family from the Jurassic and Cretaceous formations, such as Ceromya, Corimya, Circomya, Goniomya, Myopsis, etc., with Panorpa and Pholadomya, and others recalling perhaps also Cardinia, Gresslya, or Cardiacea more closely related to Conocardium than the living species, perhaps leading to Opis, or Trigoniae of extinct types akin to Myophoria, with Pachymya, Diceras, Grammisia, Inoceramus, Pterinea, Monotis and Posidonia. Rudistes should take the place of oysters and the harvest of Brachiopods should be large.

Among Crustacea it is natural to suppose that genera may be discovered reminding us of Eryon or of Pemphyx, Gampsonyx, or some Amphipods, and Isopods aping still more closely the Trilobites than Serolis, or Limuloids approaching that extinct family. The classification, embryology, and order of succession of Echinoderms is now so well known, that it is perhaps still more easy to anticipate the character of discoveries in this branch of the animal kingdom than in any other. I expect confidently, to find Spatangoids approaching Holaster, Toxaster, Ananchytes, Hemipneustes or Metaporhinus, and others akin to Dysaster; Echinolamps approaching Pygurus, Nucleolites tending to Clypeus, Gal-

erites like Pyrina or Globator, etc., etc., and again Cidarid akin to *C. glandifera* and *clavigera* with Glypticus-like species, and Codiopsis, Cœlopleurus, Cyphosoma, and Salenia.

Among Starfishes the types of Goniaster and Luidia are likely to prevail with simple rayed Euryaloid genera, and among Crinoids a variety of genera reminding us of Pentremites, Marsupites, Pentacrinus, Apiocrinus, and Eugeniacrinus.

The question of the affinities of Millepora will probably receive additional evidence, and genera connecting more closely the Rugosa and Tabulata with one another, and with the Acalephs may be expected in the shapes of branching Heliopores and the like.

With the monograph of Pourtales upon the deep-sea corals before me, it would be sheer pretence to say anything concerning the prospect of discovering new representatives of this or that type. His tables point them out already.

But, there is a subject of great interest likely to be elucidated by our investigation,— the contrast of the deep-sea faunæ of the northern with those of the southern hemisphere. Judging from what Australia has already brought us, we may expect to find that the animal world of the southern hemisphere has a more antique character, in the same way as North America may be contrasted with Europe, on the ground of the occurrence in the United States of animals and plants now living here, the types of which are only found fossil in Europe.

A few more words, upon another subject. During the first three decades of this century, the scientific world believed that the erratic boulders, which form so prominent a feature of the surface geology of Europe, had been transported by currents arising from the rupture of the barriers of great lakes among the Alps or started from the north by earthquake waves.

Shepherds first started the idea that within the valleys of Switzerland these huge boulders had been carried forward by glaciers, and Swiss geologists, Venetz and Charpentier foremost among them, very soon proved that this had been the case. This view, however, remained confined to the vicinity of the Alps in its application, until I suggested that the phenomenon might have a cosmic importance, which was proved when I discovered, in 1840, unmistakable traces of glaciers in Scotland, England, and Ireland, in regions which could have had no connection whatever with the elevation of the Alps. Since that time the *glacial period*

has been considered by geologists as a fixed fact, whatever may have been the discrepancies among them as to the extent of these continental masses of ice, their origin, and their mode of action.

There is, however, one kind of evidence wanting to remove every possible doubt that the greatest extension of glaciers in former ages was connected with cosmic changes in the physical condition of our globe. All the phenomena related to the glacial period must be found in the southern hemisphere with the same characteristic features as in the north, with this essential difference, that everything must be reversed; that is, the trend of the glacial abrasion must be from the south northward; the lee side of abraded rocks must be on the north side of hills and mountain ranges, and the boulders must have been derived from rocky exposures lying to the south of their present position. Whether this is so or not, has not yet been ascertained by direct observation. I expect to find it so throughout the temperate and cold zones of the southern hemisphere, with the sole exception of the present glaciers of Terra del Fuego and Patagonia, which may have transported boulders in every direction. Even in Europe, geologists have not yet sufficiently discriminated between local glaciers and the phenomena connected with their different degrees of successive retreat on one hand, and the facts indicating the action of an expansive and continuous sheet of ice moving over the whole continent from north to south. Unquestionably, the abrasion of the summits of the mountains of Great Britain, especially noticeable upon Schiehallion, is owing to the action of the great European ice-sheet during the maximum extension of the glacial phenomena in Europe, and has nothing to do with the local glaciers of the British Isles.

Among the facts already known from the southern hemisphere are the so-called rivers of stone of the Falkland Islands, which attracted the attention of Darwin during his cruise with Captain Fitzroy, and which have remained an enigma to this day. I believe it will not be difficult to explain their origin in the light of the glacial theory, and I fancy now they may turn out to be nothing but ground moraines, similar to the "Horsebacks" of Maine.

You may ask what the question of drift has to do with deep-sea dredging? The connection is closer than may at first appear. If drift is not of glacial origin, but the product of marine currents, its formation at once becomes a matter for the Coast Survey

to investigate, and I believe, it will be found in the end, that, so far from being accumulated by the sea, the drift of the lowlands of Patagonia has been worn away to its present extent by the continued encroachment of the ocean in the same manner as the northern shores of South America and of Brazil have been.

THE BLIND FISHES OF THE MAMMOTH CAVE AND THEIR ALLIES.*

BY F. W. PUTNAM.

The blind fish of the Mammoth Cave has from its discovery been regarded with curiosity by all who have heard of its existence, while anatomists and physiologists have considered it as one of those singular animals whose special anatomy must be studied in order to understand correctly facts that have been demonstrated from other sources; and, in these days of the Darwinian and development theories, the little blind fish is called forth to give its testimony, pro or con.

Before touching upon this point, however, we must call attention to the structure of the fish and its allies, and to others that are either partially or totally blind.

In the lancelet (Branchiostoma) and the hag (Myxine) the eye is described "as simple in form as that of a leach, consisting simply of a skin follicle† coated by a dark pigment, which receives the end of a nerve from the brain." Such an eye speck as this structure gives would only answer for the simple perception of light. In the young‡ of the lampreys (Petromyzon) the eye is very small and

*It was intended to put this article in the last number of the NATURALIST in connection with the article on the cave and its insect and crustacean life, but the delay in preparing the plates made it necessary to postpone it. We are therefore obliged to refer the reader to the December number for further information of the fauna of the cave and a short account of the cave itself. — EDS.

† See further on where Prof. Wyman questions this structure.

‡ These young lampreys have been described under the generic name of Ammoccetes, and it was not until 1856, when Prof. Müller discovered the fact of a metamorphosis in the lampreys, that their true position was ascertained. Prof. Müller has traced the history of the common European species and shown that it is three or four years in attaining its perfect form. With this fact before us and with the early stages of the Myxinoids still unknown, have we not some reason for suspecting that the Lancelet may yet prove to be a larval form of the Myxinoids, notwithstanding that it is said to lay eggs? Why should we not suspect the existence in the very lowest vertebrates of some-

placed in a fold of the skin of the head, and probably of little use, as these young remain buried in the sand; but as they attain maturity, and, with it, the parasitic habits of the adult, their eyes are developed to a fair size, thus reversing the general rule in the class.

In most other fishes the eyes are developed to a full and even remarkable extent as to size and perfection of sight in water. In Anableps, or the so called four eyed fish of the fresh waters of Central and South America, which belongs to a closely allied family with our blind fish, the *Cyprinodontidæ*, the eyes are not only fully developed, but are divided into an upper and lower portion in such a way, by an opaque horizontal line, as to give the effect of two pupils, by which the fish probably sees as well when following its prey on the surface with its eyes out of water, as when under water. But it is in the interesting family of cat fishes (*Siluridæ*) that we find the most singular arrangement of eyes in perfect adaptation to the diversified modes of life of the numerous species. In this family the eyes assume nearly every possible modification from partial and even total blindness to perfectly developed eyes, and these organs are placed in almost every conceivable position in a fish's head; from the ordinary large eyes on the side, to small ones on top of the head, enabling the fish to see only what is above; to the oval eyes on the side, in some just back of the mouth, situated in such a way that the fish can only see what is in close proximity to its jaws or even below them. Many genera of this family found in South America,* Africa† and Asia,‡ have the eyes so small and buried under the skin or protected by folds or cartilage, as evidently to be of no more use than simply to distinguish light from darkness.

Among the most interesting forms of this family, in this respect, is the genus described by Prof. Cope under the name of *Gronias nigrilabris*. This fish is very closely allied to our common bull

thing akin to alternate generations, or of larvæ capable of reproduction? Without having any facts to support such an assumption, except that, on general principles, the young of Myxine would probably be very much like Branchiostoma, and that its young is not known, while Branchiostoma has only been found in waters where some species of Myxinoid exists, I think that before the position of the lancelet is firmly established we must know the embryology of the Myxinoids; for should the lancelet prove not to be the young of the Myxinoids, it must necessarily form a distinct class of animals, perhaps as near to the mollusks as to the vertebrates.

* *Pimelodus cyclopium* of Humboldt, *Helogenes*, *Agoniosus* and other genera.

† *Eutropius congensis*.

‡ *Ailia*, *Shilbichthys*, *Bagroides* and other genera.

pout or horned pout, and of about the same size (ten inches in length). It was taken in the Conestoga river in Lancaster Co., Penn., where it is "occasionally caught by fishermen and is supposed to issue from a subterranean stream said to traverse the limestone in that part of Lancaster Co., and discharge into the Conestoga." We quote the following from Prof. Cope's remarks on the fish:*—

"Two specimens of this fish present an interesting condition of the rudimental eyes. On the left side of both a small perforation exists in the corium, which is closed by the epidermis, representing a rudimental cornea; on the other the corium is complete. Here the eyeball exists as a very small cartilaginous sphere with thick walls, concealed by the muscles and fibrous tissue attached, and filled by a minute nucleus of pigment. On the other the sphere is larger and thinner walled, the thinnest portion adherent to the corneal spot above mentioned; there is a lining of pigment. It is scarcely collapsed in one, in the other so closely as to give a tripodal section. Here we have an interesting transitional condition in one and the same animal, with regard to a peculiarity which has at the same time physiological and systematic significance, and is one of the comparatively few cases where the physiological appropriateness of a generic modification can be demonstrated. It is therefore not subject to the difficulty under which the advocates of natural selection labor, when necessitated to explain a structure as being a step in the advance towards, or in the recession from, any *unknown* modification needful to the existence of the species. In the present case observation on the species in a state of nature may furnish interesting results. In no specimen has a trace of anything representing the lens been found."

When we remember that the lens of the eye in Amblyopsis has been found, even though the eye is less developed in all its parts than in Gronias, it is probable that a careful microscopical examination would show its existence in this genus also.

It is interesting to note that this fish is black above (lighter on the sides and white below), notwithstanding its supposed subterranean habits, and that all the other members of the family having rudimentary or covered eyes are also dark colored, while the blind fishes of the Mammoth Cave and of the caves in Cuba are nearly colorless. This want of color in the latter fishes has been considered as due to their subterranean life. If this be the cause, why should the blind cat fishes retain the colors characteristic of the other members of the family living in open waters?

* Proceedings of the Academy of Natural Sciences of Philadelphia for 1864, p. 231.

The fishes which in a general way, so far as blindness, tactile sense and mode of life are concerned, come the nearest to the blind fishes of the Mammoth Cave, are those described by Prof. Poey* under the names of *Lucifuga subterraneus* and *L. dentatus*.† These fishes having the broad, flattened, fleshy head, with minute cilia, without external eyes, and inhabiting caves so similar in structure to the Mammoth Cave, make a comparison of them with the fishes of the Mammoth Cave most interesting. This is greatly enhanced by the fact that the Cuban fishes belong to a family of essentially marine habit, quite far removed from Amblyopsis. The fresh water ling (Lota), belonging to the same great group of fishes (though to a distinct family or subfamily) containing the cod on the one hand and the Cuban blind fish on the other, is probably the nearest fresh water relative of the Cuban fish, but the nearest representative yet known is the marine genus Brotula, one species of which is found in the Caribbean Sea.

In the Cuban blind fish we find ciliary appendages on the head and body quite distinctly developed, evidently of the same character as those of Amblyopsis and answering the purpose of tactile organs. These cilia are in the form of small, but plainly visible, protuberances (reminding one of the single fleshy protuberance over the opercular opening just back of the head in Amblyopsis). There are eight of these on top of the head of a specimen I hastily examined, received from Prof. Poey by the Museum of Comparative Zoology, and quite a number arranged in three rows on each side of the body, showing that tactile sense is well developed in this fish; though it is rather singular that the barbels on the jaws, so usually developed as organs of touch in the cod family and its allies, are entirely wanting in this fish.

The brain of *Lucifuga subterraneus*, as represented by the figures of Poey, differs very much from that of *L. dentatus* and of Amblyopsis. In all, the optic lobes are as largely developed as in allied fishes provided with well developed eyes. In *Lucifuga subterraneus* the cerebral lobes are separated by quite a space from the

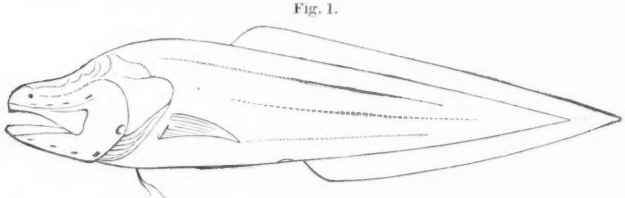
*Memorias Sobre la Historia Natural de la Isla de Cuba, por Felipe Poey. Tomo 2. pp. 95–114. Pls. 9, 10, 11. Habana. 1855–8.

†This species was afterwards referred to the genus *Stygicola* Gill, on account of the presence of palatine teeth which are wanting in the other species. There are also several other good characters, to judge from the figures of the head, skull and brain given by Poey, that would warrant the reference of the fish to a distinct genus from *L. subterraneus*.

round optic lobes, which are represented as a little larger than the cerebral lobes, and also of greater diameter than the cerebellum; this latter being more developed laterally than in either *L. dentatus* or in Amblyopsis. The three divisions of the brain are represented, from a top view, as nearly complete circles (without division into right and left lobes), of which that representing the optic lobes is slightly the largest. In *L. dentatus* the procencephalon and the optic lobes are represented as divided into right and left lobes, as in Amblyopsis, and the cerebellum does not extend laterally over the medulla oblongata as in *L. subterraneus*, but, as in Amblyopsis (Pl. 1, fig. 1 *d*), is not so broad as the medulla, and, projecting forwards, covers a much larger portion of the optic lobes than is the case in *L. subterraneus*.

The Cuban blind fish has the body, cheeks and opercular bones covered with scales. As in Amblyopsis the eyes exist, but are so

Fig. 1.



Blind Fish (*Stygicola dentatus*) from Caves in Cuba.

imbedded in the flesh of the head as to be of no use. The outline cut here given (Fig. 1), copied from Poey, is very characteristic of the form of the fish, but does not exhibit the fleshy cilia or details of scaling.

The first notice that I can find of the Mammoth Cave blind fish is that contained in the "Proceedings of the Academy of Natural Sciences of Philadelphia," Vol. 1, page 175, where is recorded the presentation of a specimen to the Academy by W. T. Craige, M. D., at the Meeting held on May 24, 1842, in the following words:—

"A white, eyeless crayfish (*Astacus Bartoni?*) and a small white fish, also eyeless (presumed to belong to a subgenus of Silurus), both taken from a small stream called the 'River Styx' in the Mammoth Cave, Kentucky, about two and one-half miles from the entrance."

Dr. DeKay in his "Natural History of New York, Fishes," page 187, published in 1842, describes the fish, from a poor specimen in

the Cabinet of the Lyceum of Natural History of New York, under the name of *Amblyopsis* spelæus*.† DeKay's description is on the whole so characteristic of the fish as to leave no doubt as to the species he had before him, though the statement that it has eight rays supporting the branchiostegal membrane (instead of six), and that the eyes are "large" but under the skin, must have been due to the bad condition of his specimen and to his taking the fatty layer covering the minute eyes for the eyes themselves, as pointed out by Prof. Wyman. Dr. DeKay places the genus with the Siluridæ (cat fishes) but at the same time questions its connection with the family and says that it will probably form the type of a new family. In 1843 Prof. Jeffries Wyman‡ gave an account of the dissection of a specimen in which he could not find a trace of the eye or of the optic nerve, probably owing to the condition of the specimen, as he afterwards§ found the eye spots, and made out the structure of the eye. When describing the brain, Prof. Wyman calls attention to the fact of the optic lobes being as well developed as in allied fishes with well developed eyes, and asks if this fact does not indicate that the optic lobes are the seat of other functions as well as that of sight. He also calls attention to the papillæ on the head as tactile organs furnished with nerves from the fifth pair.

Dr. Theo. Tellkampf‖ was the first to point out the existence of the rudimentary eyes from dissections made by himself and Prof. J. Müller, and to state that they can be detected in some specimens as black spots under the skin by means of a powerful lens. Prof. Wyman afterwards detected the eye through the skin in several specimens. Dr. Tellkampf also was the first to call attention to the "folds on the head, as undoubtedly serving as organs of touch, as numerous fine nerves lead from the trigeminal nerve to them and to the skin of the head generally."

It is also to Dr. Tellkampf that we are indebted for the first figure of the fish,¶ and for figures illustrating the brain, and internal organs. The descriptions of the anatomy of the fish by Drs.

* Obtuse vision. † Of a cave.

‡ Silliman's Journal, Vol. 45, p. 94.

§ Proceedings Boston Soc. Nat. Hist., Vol. 4, p. 395. 1853.

‖ Müller's Archiv. fur Anat., 1844. p. 392. Reprinted in the New York Journal of Medicine for July, 1845. p. 84, with plate.

¶ The only other figures of the species, that I am aware of, are the simple outlines given in Poey's Mem. de Cuba, the woodcut in Wood's Illustrated Natural History and the cut in Tenney's Zoology. None of these figures are very satisfactory.

Tellkampf and Wyman are all that have ever been written on the subject of any importance, with the exception of the description of the eye by Dr. Dalton, whose paper, in the "New York Medical Times," Vol. 2, p. 354, I have not seen. Prof. Poey gives a comparison of portions of the structure with that of the Cuban blind fishes.

Dr. Tellkampf proposed the name of *Heteropygii** for the family of which, at the time, a single species from the Mammoth Cave was the only known representative, and makes a comparison of the characters with those of *Aphredoderus Sayanus*, a fish found only in the fresh waters of the United States, and belonging to the old family of Percoids, but now considered as representing a family by itself, though closely allied to the North American breams (Pomotis), and having the anal opening under the throat as in the blind fish.

Dr. Storer,† not knowing of Dr. Tellkampf's paper, proposed the name of *Hypsæidæ*, for the blind fish, and placed it between the minnow and the pickerel families, in the order of Malacopterygian, or soft rayed, fishes. According to the system adopted by Dr. Günther, it stands as closely allied to the minnows, *Cyprinodontidæ* (many of which are viviparous and have the single ovary and general character of the blind fish), and the shiners, *Cyprinidæ*, of the order of Physostomi. Dr. Tellkampf, in discussing the relations of the family, points out its many resemblances to the family of Clupesoces, and its differences from the Siluroids, Cyprinodontes and Clupeoids, with which it has more or less affinity, real or supposed. Prof. Cope in his paper on the Classification of Fishes‡ places the Amblyopsis in the order of Haplomi with the shore minnows, pickerel and mud fish, and in an article on the Wyandotte Cave,§ he says that the Cyprinodontes (shore minnows) are its nearest allies. This arrangement by Prof. Cope places the Haplomi between the order containing the herrings and that containing the electric eel of South America, all included with the garpike, dog fish of the fresh waters (Amia), cat fishes, suckers and eels proper, etc., etc., in the division of Physostomi as limited by him.

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*From the advanced position of the terminus of the intestine being so different from the position which it has in ordinary fishes.

† Synopsis of the Fishes of North America, published in 1846.

‡ American Naturalist, Vol. 5, p. 579, 1871.

§ Indianapolis Daily Journal of September 5, 1871. Reprinted in Ann. Mag. Nat. Hist., Nov., 1871.

Prof. Agassiz in 1851* stated that the blind fish was an aberrant form of the Cyprinodontes.

Thus all those authors who have expressed an opinion as to the position which the fish should hold in the natural system have come to the same conclusions as to the great group, division, or order, into which it should be placed. For all the terms used above, when reduced to any one system, bring Amblyopsis into the same general position in the system; its nearest allies being the minnows, pickerels, shiners and herrings; and unless a careful study of its skeleton should prove to the contrary, we must, from present data, consider the family containing Amblyopsis as more nearly allied to the Cyprinodontes, or our common minnows having teeth on the jaws, than to any other family, differing from them principally by the structure of the several parts of the alimentary canal and the forward position of its termination.

I have thus far mentioned only one species of blind fish from the cave, the *Amblyopsis spelæus*. The waters of the cave not only contain another species of blind fish, differing from Amblyopsis in several particulars, especially by its smaller size and by being without ventral fins, which I have identified as the *Typhlichthys subterraneus* of Dr. Girard; but also a fish with well developed eyes, as proved by the account given by Dr. Tellkampf and by the drawing of a fish found by Prof. Wyman, in 1856, in the stomach of an Amblyopsis he was dissecting. In order to call attention to the fact that fishes with eyes are at times, if not always, in the waters of the cave, I have reproduced the drawing by Prof. Wyman on plate 1, fig. 13. It is very much to be regretted that the specimen is not now to be found, and that it was so much acted on by the gastric juice as to destroy all external characters by which it could be identified from the drawing, which is of about natural size. Dr. Tellkampf's remarks on the fish with eyes are as follows: —

"Besides the colorless blind-fish, there are also others found in the cave, which are black, commonly known by the name of 'mud-fish.' I saw a dark-colored fish in the water, but did not succeed in catching it. The latter are said to have eyes, and are entirely dissimilar to the blind-fish."

The name "mud-fish," given to this fish with eyes, and the statement that it is of a dark color, together with the drawing by Prof.

*Silliman's Journal. p. 128.

Wyman of the fish found in the stomach of the blind fish, showing the position of the dorsal fin to be the same as in the fish commonly called mud fish in the fresh waters of the Middle, Western and Southern States, perhaps, indicates the fish with eyes to be a species of *Melanura*.* This fish is called mud fish from the habit it has of burying itself in the mud, tail first,† to the depth of two to four inches, and of remaining buried in the mud in our western ditches during a time of drought. This habit, perhaps, in a measure fits it for a subterranean life. The occurrence of a fish belonging to the same family with the blind fish, but with well developed eyes, in the subterranean streams in Alabama, as mentioned further on and figured on Pl. 2, fig. 4, however, renders it probable that the cave fish with eyes may be the same or an allied species, and the drawing by Prof. Wyman would answer equally as well for it.

The fact that the Amblyopsis succeeded in catching a fish of, probably, very rapid and darting movements, shows that the tactile sense is well developed and that the blind fish must be very active in the pursuit of its prey; probably guided by the movement which the latter makes in the water so sensibly influencing the delicate tactile organs of the blind fish that it is enabled to follow rapidly, while the pursued, not having the sense of touch so fully developed, is constantly encountering obstacles in the darkness.

In describing the habits of the blind fish Dr. Tellkampf says:—

"It is found solitary, and is very difficult to be caught, since it requires the greatest caution to bring the net beneath them without driving them away. At the slightest motion of the water they dart off a short distance and usually stop. Then is the time to follow them rapidly with a net and lift them out of water. They are mostly found near stones or rocks which lie upon the bottom, but seldom near the surface of the water."

Prof. Cope, in describing the habits of the blind fish which he

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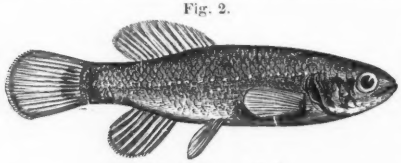
* Dr. Günther considers the genus Melanura of this country to be synonymous with Umbla of Europe. In each country only one species has been as yet satisfactorily described.

Fig. 2.



Mud fish (*Melanura limi*).

† See the interesting notes on the habits of the mud minnow, by Dr. Abbott in American Naturalist, Vol. 4, pages 107 and 388, with figure of the fish on page 385, which we here reproduce for comparison.

obtained in a stream that passes into the Wyandotte Cave, though he entered it by means of a well in the vicinity of the cave, says that: —

"If these Amblyopses be not alarmed they come to the surface to feed, and swim in full sight like white aquatic ghosts. They are then easily taken by the hand or net, if perfect silence be preserved, for they are unconscious of the presence of an enemy except through the sense of hearing. This sense is, however, evidently very acute, for at any noise they turn suddenly downward, and hide beneath stones, etc., on the bottom. They must take much of their food near the surface, as the life of the depths is apparently very sparse. This habit is rendered easy by the structure of the fish, for the mouth is directed upwards, and the head is very flat above, thus allowing the mouth to be at the surface."

The blind fish has a single ovary, in common with several genera of viviparous Cyprinodontes. In three female specimens of Amblyopsis which I have opened, the ovary was distended with large eggs, but no signs of the embryo could be traced. In these three specimens it was the right ovary that was developed, and this, as in the figure (Plate 2, fig. 1*c*), was by the side of the stomach and did not extend beyond it. The number of eggs contained in the ovary was not far from one hundred in the specimen figured. As the embryos develop, the mass probably pushes further back in the cavity and also extends the abdominal walls. That the fish is viviparous is proved by the statement made by Mr. Thompson before the Belfast Natural History Society,* that one of the blind fishes from the cave, four and a half inches long, "was put in water as soon as captured, where it gave birth to nearly twenty young, which swam about for some time, but soon died. These, with the exception of one or two, were carefully preserved, and fifteen of them are now before us [at the meeting. I wish they were here], they were each four lines in length."

It is singular that no mention is made regarding these young, as to the presence or absence of eyes, and, as if it was fated that this important point should remain unnoticed as long as possible, it is equally singular that Dr. Steindachner omitted to examine some very young specimens which he received from a friend a few months since and sent to the Vienna Museum, where they will remain unexamined until he returns there. I saw the Doctor only

* Annals and Mag. of Natural History, Vol. xiii, pp. 112, 1844.

a week after these, to me, interesting specimens had been sent abroad, and he was as grieved as I was disappointed at my being just too late to take advantage of them.

At what time the young are born has never been stated, but judging from such data as I can at present command, I think that it must be during the months of September and October. Specimens collected during those months would probably contain embryos in various stages of development, the examination of which would undoubtedly lead to most interesting results.

Prof. Wyman has most generously placed in my hands his unpublished notes and drawings of the several dissections he has made of Amblyopsis, as well as his specimens and dissections. Many of these drawings are reproduced on Plate 1, and will, with his notes which I here give, greatly enhance the value of this article, as his dissections have been made with the utmost care, and with a patience and delicacy that only a master hand attains. It will therefore be understood that, in giving credit to Prof. Wyman in the following pages, I refer to his unpublished notes, except when the quotation is given from a special work. In quoting his description of the eye and ear from "Silliman's Journal" I have changed the references so as to refer to his drawings reproduced on Plate 1, and not to the three cuts given in "Silliman's Journal," though the figures of the brain and of the otolite were copied from those cuts.

The largest specimens I have seen of Amblyopsis are several males and females, each from four to four and a half inches in length, which seems to be about as large as the fish grows, though Dr. Günther mentions a specimen in the British Museum of five inches in length. The largest specimen captured of late years is said to have been taken, during the summer of 1871, and sold for ten dollars to a person who was so desirous of securing the precious morsel that he had it cooked for his supper. The smallest specimen I have seen was one and nine-tenths inches in length. The general shape and character of the fish is best shown by the figures on plates 1 and 2.

"The whole head, above and below, is destitute of scales, the naked skin extending backwards on the sides to the base of the pectoral fins; the scaly portion of the body above ends in a semicircular edge covering the space between the upper ends of the opercula. The skin covering the middle region of the head is

smooth, but on either side is provided with numerous transverse and longitudinal ridges (Pl. 1, fig. 7), which are, on the whole, regularly arranged. The first row of transverse ridges, eight or nine in number, begins between the nostrils and extends backwards, diverging from the median line. The third ridge is crossed at its outer end by a longitudinal one, as are also two others farther back. The second and third rows, situated, in part, on the sides and, in part, on the under surface, are less regular than the preceding. A fourth, on the borders of the operculum, is still less well defined. The transverse are also crossed here by longitudinal ridges. About ten vertical ridges, also provided with papillæ, and similar to those on the head, are visible on the sides extending from the pectoral fins to the tail, but are not so well defined as those on the head. The skin of the head is of extreme delicacy and is covered by a very thin, loose layer of epithelium."—WYMAN.

"The larger ridges have between twenty and thirty papillæ, many of these having a cup-shaped indentation at the top, in which a delicate filament is, in some instances, seen (Pl. 1, fig. 9). These papillæ are largely provided with nervous filaments, and, as is obvious from their connection with branches of the fifth pair of nerves, must be considered purely tactile, and the large number of them shows that tactile sensibility is probably very acute and in some measure compensates for the virtual absence of the sense of sight. Plate 1, fig. 8, represents one of the ridges of the head magnified, showing the papillæ of which it is made up, and figure 9 shows three papillæ still more enlarged. Two of these show a cup-shaped cavity at the top, and the short, slender filament already mentioned. The surface of the papillæ is covered with loosely connected epithelium cells. Fig. 10 shows the nervous filaments distributed to the papillæ: *a*, a branch of the fifth pair of nerves passing beneath the papillary ridge and sending filaments to each papilla. These papillary branches interchange filaments, forming a nervous plexus in connection with each ridge. This figure of the nerves was drawn with a camera lucida, from a specimen treated with acetic acid."—WYMAN.

"Plate 1, fig. 6, represents a double system of subcutaneous canals, which extend the whole length of the head, but were not traced farther back than the edge of the naked or scaleless skin which covers it. Forwards they bifurcate, nearly encircling the nasal cavity, towards the middle line ending in a blind pouch.

The lateral branch was not traced distinctly to an end, but seemed to connect with the olfactory cavity. The walls of these canals are exceedingly delicate and easily overlooked."—WYMAN.

"Plate 1, fig. 5, shows the globe of the eye with the optic nerve (*c*), as seen under the microscope. The lens (*b*) is detached from its proper place by the pressure of the glass. Irregularly arranged muscular bands are attached to the exterior of the globe (*a*, *a*, *a*, *a*), but were not recognized as the homologues of the muscles of the normal eye of fishes; nevertheless, they indicate that the globe was moveable."—WYMAN.

"In the three specimens recently dissected, the eyes were exposed only after the removal of the skin, and the careful separation from them of the loose areolar tissue which fills the orbit. In a fish four inches in length the eyes measured one-sixteenth of an inch in their long diameter, and were of an oval form and black. A filament of nerve (Pl. 1, fig. 3*a*) was distinctly traced from the globe to the cranial walls, but the condition of the contents of the cranium, from the effects of the alcohol, was such as to render it impracticable to ascertain the mode of connection of the optic nerve with the optic lobes.

Examined under the microscope with a power of about twenty diameters, the following parts were satisfactorily made out (Pl. 1, fig. 3): 1st, externally an exceedingly thin membrane, *b*, which invested the whole surface of the eye and appeared to be continuous with a thin membrane covering the optic nerve, and was therefore regarded as a sclerotic; 2d, a layer of pigment cells, *d*, for the most part of a hexagonal form, and which were most abundant about the anterior part of the eye; 3d, beneath the pigment a single layer of colorless cells, *c*, larger than a pigment cell, and each cell having a distinct nucleus; 4th, just in front of the globe, a lenticular-shaped, transparent body, *e* [see also fig. 4], which consisted of an external membrane containing numerous cells with nuclei. This lens-shaped body seemed to be retained in its place by a prolongation forwards of the external membrane of the globe; 5th, the globe was invested by loose areolar tissue, which adhered to it very generally, and in some instances contained yellow fatty matter; in one specimen it formed a round spot, visible through the skin on each side of the head, which had all the appearance of a small eye; its true nature was determined by the microscope only. It is not improbable that the appearance just referred to may have misled Dr. DeKay—where he states that the eye exists of the usual size, but covered by the skin.

If the superficial membrane above noticed is denominated correctly the *sclerotic*, then the pigment layer may be regarded as the representation of the *choroid*. The form as well as the position of the transparent nucleated cells within the choroid correspond

for the most part with the *retina*. All of the parts just enumerated are such as are ordinarily developed from and in connection with the encephalon, and are not in any way dependent upon the skin. But if the lenticular-shaped body is the true representative of the crystalline lens, it becomes difficult to account for its presence in Amblyopsis according to the generally recognized mode of its development (since it is usually formed from an involution of the skin) unless we suppose that after the folding in of the skin had taken place in the embryonic condition, the lens retreated from the surface, and all connection with the integument ceased.[*]

According to Quatrefages, however, the eye of Amphioxus [†] is contained wholly in the cavity of the dura mater, and yet it has all the appearance of being provided with a lens. If his description be correct, then the mode of development as well as the morphology of the eye in this remarkable fish is different from that of most other vertebrates, since the lens never could have been formed from an involution of the skin, nor could the eye with its lens, as Prof. Owen asserts, be a modified cutaneous follicle. Whatever views be taken with regard to the development of the eye of the blind fish, the anatomical characters which have been enumerated show, that though quite imperfect as we see it in the adult, it is constructed after the type of the eyes of other vertebrates. It certainly is not adapted to the formation of images, since the common integument and the areolar tissue which are interposed between it and the surface, would prevent the transmission of light to it except in a diffused condition. No pupil or anything analogous to an iris was detected, unless we regard as representing the latter the increased number of pigment cells at the anterior part of the globe.

It is said that the blind fishes are acutely sensitive to sounds as well as to undulations produced by other causes in the water. In the only instance in which I have dissected the organ of hearing (which I believe has not before been noticed), all its parts were largely developed, as will be seen by reference to Pl. 1, fig. 1*e*. As regards the general structure, the parts do not differ materially from those of other fishes except in their proportional dimensions. The semi-circular canals are of great length, and the two which unite to enter the vestibule by a common duct, it will be seen, project upwards and inwards under the vault of the cranium, so as to approach quite near to the corresponding parts of the opposite side. The otolite contained in the utricle was not remarkable, but that of the vestibule (Pl. 1, fig. 2) and seen in

*In birds and mammals there is a stage of development where the lids come together and firmly unite, to separate again when the animal "gets his eyes open." In the mole rat (*Spalax typhlus*) of Siberia, the lids never open, and the eyes remain through life covered with hairy skin. It is not improbable that in Amblyopsis something analogous to this, a closing of the skin over the eye, may have taken place.—J. W.

†I have used the prior name of *Branchiostoma* in this paper when speaking of the Lancelet.

dotted outline in fig. 1 *e* is quite large when compared with that of a Leuciscus of about the same dimensions as the blind-fish here described."—WYMAN, *Silliman's Journal*, *Vol.* 17, *p.* 259, 1854.

The *Amblyopsis spelæus* undoubtedly has quite an extensive distribution, probably existing in all the subterranean rivers that flow through the great limestone region underlying the Carboniferous rocks in the central portion of the United States. Prof. Cope obtained specimens from the Wyandotte Cave and from wells in its vicinity, and in the Museum of Comparative Zoology at Cambridge there is a specimen labelled "from a well near Lost River, Orange Co., Ind.," which, with those from the Wyandotte Cave, is conclusive evidence of its being found on the northern side of the Ohio* as well as on the southern, in the rivers of the Mammoth Cave. I have been able to examine a number of specimens from the Mammoth Cave, and have carefully compared with them the one from the well in Orange Co., Ind., and find that the specific characters are remarkably constant.

In 1859† Dr. Girard described a blind fish, received by the Smithsonian Institution from J. E. Younglove, Esq., who obtained it "from a well near Bowling Green, Ky." The general appearance of this fish, which was only one and a half inches in length, was that of *Amblyopsis spelæus*, but it differed from that species in several characters, especially by the *absence* of ventral fins. Dr. Girard therefore referred the fish to a distinct genus under the name of *Typhlichthys*‡ *subterraneus*. Dr. Günther§ considers this fish a variety of *Amblyopsis spelæus* and records the specimen in the British Museum "from the Mammoth Cave," as "half-grown."‖

By the kindness of Prof. Agassiz, I have been enabled to examine nine specimens of *blind fish without ventrals*, in the Museum of Comparative Zoology. Seven of these were collected in the Mammoth Cave by Mr. Alpheus Hyatt in September, 1859. One was from Moulton, Lawrence County, Alabama, presented by Mr. Thomas Peters; and another from Lebanon, Wilson Co., Tennessee; presented by Mr. J. M. Safford. It is not stated whether

*I have also been informed by Mr. Holmes of Lansing, Mich., that *blind fishes* have been drawn out of wells in Michigan.

†Proceedings Acad. Nat. Sci. Philad., p. 63.

‡Blind fish.

§Catalogue of Fishes in the British Museum, Vol. 7, p. 2, 1868.

‖The largest specimen I have seen of Typhlichthys is one and seventeen-twentieths inches in length, and the smallest Amblyopsis one and eighteen-twentieths inches.

these latter came from wells or caves, but probably from wells. They are all of about the same size, one and one-half to two inches in length, and are constant in their characters. Moreover, four of the seven specimens from the Mammoth Cave were females with eggs. These eggs were as large in proportion as those from Amblyopsis. The ovary was single and situated on the right side of the stomach, as in Amblyopsis. The difference in the number of eggs was very remarkable, each of the four specimens examined having but about thirty eggs in the ovary, while in three females of Amblyopsis (all, however, of nearly three times the size of Typhlichthys) there were about one hundred eggs in each. As in both species there were no signs of the embryos in the eggs, it is not probable that any of the eggs had been developed and the young excluded, nor is it at all likely that the great variation in the number of eggs would simply indicate different ages. By a reference to the figures (Pl. 2), it will be seen that the pyloric appendages, stomach and scales of the two fishes are different. For these reasons, taken in connection with the absence of ventral fins, I have no hesitation in accepting Dr. Girard's name as valid for this genus, of which we thus far know of but one species, with a subterranean range from the waters of the Mammoth Cave, south to the northern portion of Alabama. In this connection it would be most interesting to know the relations of the "blind fishes" said to have been found in Michigan. For thus far we have Typhlichthys limited to the central and southern portion of the subterranean region, Amblyopsis to the central, and the species in the northern portion undetermined.

In 1853, on his return from a tour through the southern and western states, Prof. Agassiz gave a summary of some of his ichthyological discoveries in a letter to Prof. J. D. Dana.* In this letter are the following remarks:—

"I would mention foremost a new genus which I shall call *Chologaster*, very similar in general appearance to the blind fish of the Mammoth Cave, though provided with eyes; it has, like Amblyopsis, the anal aperture far advanced under the throat, but is entirely deprived of ventral fins; a very strange and unexpected combination of characters. I know but one species, *Ch. cornutus* Ag. It is a small fish scarcely three inches long, living in the ditches of the rice fields in South Carolina. I derive its specific

* Published in American Journal of Sci. and Arts, Vol. 16 (2d series), p. 134, 1853.

name from the singular form of the snout, which has two horn-like projections above."

This is the only information ever published regarding this interesting fish and the only specimens known are those on which Prof. Agassiz based the above remarks.

By the kindness of Professor L. Agassiz, who has placed all the specimens of the family contained in the Museum of Comparative Zoology in my hands for study, I am enabled to give a figure and description of this interesting species from the three specimens in the Museum, which were labelled as the originals of *Chologaster cornutus* Ag., from Waccamaw, S. C., presented by Mr. P. C. J. Weston, 1853. The largest of these specimens was distended with eggs and I was enabled to compare the ovary with that of Amblyopsis. From its being single and the eggs very large, I have no doubt that it is a viviparous fish like the other genera of the family. The position of the ovary behind the stomach, as shown in fig. 2*c*, plate 2, and the presence of four pyloric appendages (Pl. 2, fig. 2*a*) instead of two, as in Amblyopsis (fig. 1*a*) and Typhlichthys (fig. 3*a*), are good internal characters, separating it from the other genera, independently of the presence of eyes and the absence of ventral fins and papillary ridges.

The stability of the internal characters I have mentioned was most unexpectedly substantiated by the discovery of a second species (Pl. 2, figs. 4, 4*a*) of the genus among the specimens in the Museum of Comparative Zoology. I have the pleasure of dedicating this species* to Professor Agassiz, not only in kindly remembrance of the eight years I was associated with him as student and assistant, but also because the fish so well illustrates the decided position he has taken relative to the immutability of species.

The only specimen known of this second species was drawn from a well in Lebanon, Tenn., and presented to the Museum by Mr. J. M. Safford, Jan., 1854. It is a more slender fish than *C. cornutus*, but the intestine follows the same course and the four pyloric appendages are present as in that species.

In the genus Chologaster† we have all the family characters as well expressed as in the blind species, though it differs from Am-

* A Synopsis of this family with descriptions of the four species will appear in the "Report of the Peabody Academy of Science for 1871."

† Literally "bile-stomach;" probably named from the yellow color of the fish.

blyopsis and Typhlichthys by the presence of eyes, the absence of papillary ridges on the head and body, and by the longer intestine and double the number of pyloric appendages, as well as by the position of the ovary; and agrees with Typhlichthys by the absence of ventral fins. Amblyopsis and Typhlichthys are nearly colorless, while *Chologaster Agassizii* is of a brownish color similar to many of the minnows, and *C. cornutus* is brownish yellow, with dark, longitudinal bands.

Among the most interesting points in the history of this genus is the fact of its occurring in two widely different localities, *C. Agassizii* having been found in a well, in the same vicinity (probably in the same well) with a specimen of Typhlichthys, and undoubtedly belonging to the same subterranean fauna west of the Appalachian ridge, while *C. cornutus* belongs to the southern coast fauna of the eastern side of that mountain chain, and is thus far the only species of the family known beyond the limits of the great subterranean region of the United States.

Having now given an outline of the structure, habits and distribution of the four species belonging to the family, and recapitulated the known facts, we are better able to consider the bearings of the peculiar adaptation of the blind fishes, in the Mammoth and other caves, to the circumstances under which they exist.

Prof. Cope in stating, in his account of the blind fish of the Wyandotte Cave, "that the projecting under jaw and upward direction of the mouth renders it easy for the fish to feed at the surface of the water, where it must obtain much of its food," suggests that: —

"This structure also probably explains the fact of its being the sole representative of the fishes in subterranean waters. No doubt many other forms were carried into the caverns since the waters first found their way there, but most of them were like those of our present rivers, deep water or bottom feeders. Such fishes would starve in a cave river, where much of the food is carried to them on the surface of the stream. . . . . The shore minnows are their nearest allies, and many of them have the upturned mouth and flat head. . . . . Fishes of this, or a similar family, enclosed in subterranean waters ages ago, would be more likely to live than those of the other, and the darkness would be very apt to be the cause of the atrophy of the organs of sight seen in the Amblyopsis."

This suggestion was undoubtedly hastily made by Prof. Cope when writing the letter which was printed in the "Indianapolis

Journal," and were it not that the article has been reprinted in the "Annals and Magazine of Natural History," I should not criticise the statement made in an off-hand letter for publication in a newspaper; for with Prof. Cope's knowledge of fishes it could simply be a hasty thought which he put on paper, when he suggests that it is because the Cyprinodontes have a mouth directed upwards and are surface feeders that they were better adapted to a subterranean life than other fishes, and hence maintained an existence, while other species, which he supposes were introduced into the subterranean streams at the same time, died out.

If the fishes of the subterranean streams came from adjoining rivers, why were not many of the Percoids, Cyprinoids and other forms, that are as essentially surface feeders as the Cyprinodontes (many of the latter are purely "mud feeders"), as capable of maintaining an existence in the subterranean waters as any species of the latter? Neither is it necessary for us to assume that the structure of the fish should be adapted to feeding on the surface, for not only have we in the blind cat fish, described by Prof. Cope himself, from the subterranean stream in Pennsylvania, an example of a fish belonging to an entirely different family of bottom feeders, thriving under subterranean conditions, but the blind fishes of the Cuban caves are of the great group of cod fishes which are, with hardly an exception, bottom feeders. The fact that the food of the blind fishes of the Mammoth Cave consists in great part of the cray fish found in the waters of the cave, as shown by the contents of several stomachs I have examined, and also that one blind fish at least made a good meal of another fish, as already mentioned, shows that they are not content with simply waiting for what is brought to them on the surface of the water, and that they are probably as much bottom as surface feeders.

Again, in regard to the sense of sight, why is it necessary to assume that because fishes are living in streams where there is little or no light, that it is the cause of the non development of the eye and the development of other parts and organs? If this be the cause, how is it that the Chologaster from the well in Tennessee, or the "mud fish" of the Mammoth Cave are found with eyes? Why should not the same cause make them blind if it made the Amblyopsis and Typhlichthys blind? Is not the fact, pointed out by Prof. Wyman, that the optic lobes are as well developed in Amblyopsis as in allied fishes with perfect eyes, and, I may add,

as well developed as those of *Chologaster cornutus*, an argument in favor of the theory that the fishes were always blind and that they have not become so from the circumstances under which they exist? If the latter were the case and the fishes have become blind from the want of use of the eyes, why are not the optic lobes also atrophied, as is known to be the case when other animals lose their sight? I know that many will answer at once that Amblyopsis and Typhlichthys have gone on further in the development and retardation of the characters best adapting them to their subterranean life, and that Chologaster is a very interesting transitionary form between the open water Cyprinodontes and the subterranean blind fishes. But is not this assumption answered by the fact that Chologaster has every character necessary to place it in the same family with Amblyopsis and Typhlichthys, while it is as distinctly and widely removed from the Cyprinodontes as are the two blind genera mentioned?

Assuming, for the moment, that Chologaster is a transitional form between the surface feeding Cyprinodontes, and Typhlichthys and Amblyopsis, let us recapitulate the characters that distinguish the different forms and see if they exhibit transitions, and if Chologaster is traversing the slow developmental road to Amblyopsis.

Allowing all characters embraced in the general structure of the skeleton, brain, scales, fins, etc., as ordinal, and common to both Cyprinodontes and Heteropygii, we will recapitulate only such as can be considered of family and generic value in the two groups.

	CYPRINODONTES.	CHOLOGASTER.	TYPHLICHTHYS.	AMBLYOPSIS.
Surface feeders.	In part.	Unknown.	Partially.	The same.
Intestine.	In many genera long and convoluted, in others short and with single turn.	Moderately long with two turns.	Shorter with two turns.	The same.
Stomach & pyloric appendages.	In most, if not all, stomach not well defined from intestine and without appendages.	Stomach well defined, cæcal, with two pyloric appendages on each side.	The same, with one pyloric appendage on each side.	The same.
Viviparous.	Many genera.	Probably.	Probably.	Undoubtedly.
Ovary.	Single in viviparous genera* and placed by the side of intestine in some and posterior in others.	Single and placed behind the stomach.	Single and placed at side of stomach.	The same.

* The ovary is also single in other genera of viviparous fishes belonging to distinct orders.

Anal opening.	In normal position.	Forward of pectorals.†	The same.	The same.
Air bladder.	Present in few genera.‡	Present.	The same.	The same.
Scales.	On body regularly imbricated and loosely attached.	Irregularly arranged, firmly attached by being covered in great part by the cuticle.	The same.	The same.
Head with scales or naked.§	With scales.	Naked.	The same.	The same.
Tactile papillæ‖ on the head and body.	Absent.	Absent.	Very prominent as ridges on the head and sides of body.	The same.
Ventral fins.¶	Present in most genera, absent in at least two.	Absent.	Absent.	Present.
*Eyes.***	Well developed in all.	Well developed and normal.	Rudimentary†† and of no use.	The same.
Habitat.	Fresh water; brackish water; salt water.	Limestone water of subterranean rivers. Brackish water?	Limestone water of subterranean rivers.	The same.
Geographical range.	Nearly all parts of the world.	One species in subterranean streams of S. central portion of the U. S.; a 2d species in the So. Atl. coast fauna of U. S.	Central & southern portion of subterranean fauna of United States.	Central and N. central portion of same.

From this brief comparison of some of the prominent characters of the genera of the Heteropygii with the Cyprinodontes, their

† Aphredoderus and Gymnotus, and other genera of distinct orders have this forward position of the anus also.

‡ The air bladder is in several families present in some species and absent in others.

§ The presence or absence of scales on the head, or on portions of it, is a generic character subject to great variation in many families and quite constant in others.

‖ I cannot recall anything but the barbels on the head and jaws of many genera, of Cyprinoids, Siluroids, Gadoids, etc., etc., that can be said to be tactile organs, among fishes, with the exception of the fleshy papillæ on the head and body of the blind fishes of the American and Cuban caves, and the filaments of the fin rays of many fishes and the fleshy ventral rays of the Gurnards.

¶ Of all fins, the ventrals are the most likely to deviate from their normal structure and position. Their presence or absence, as exhibited in many families, and often by different ages of the same fish, and the great variation in their position in different genera of the same family, render any change in them of either generic, specific, or individual character, or simply indicative of age (as they are lost in some adult fishes while present in the young, and in others not developed until after the other fins).

** As I have alluded to the fact, in the first part of this paper, the eyes of fishes are no more the constant and unvarying part of the fish structure than the ventral fins, and like them are subject to almost every conceivable variation in position in the head, and perfection in structure.

†† The largest specimen I have seen of Typhlichthys, is less than two inches in length, and as the eye of an Amblyopsis of twice the size is not over a 32d of an inch in width, it must be very small indeed in Typhlichthys, and I confess to not being able to find it in an ordinary dissection, assisted only by a good lens.

acknowledged nearest allies, we can only trace what could be regarded as a transition, or an acceleration, or a retardation of development, in simply those very characters, of eyes and ventral fins, that are in themselves of the smallest importance in the structure (permanence of character considered) of a fish, and, as if to show that they were of no importance in this connection, we find in the same cave, blind fishes with ventrals and without, and in the same subterranean stream, a blind fish and another species of the family with well developed eyes.

If it is by acceleration and retardation of characters that the Heteropygii have been developed from the Cyprinodontes, we have indeed a most startling and sudden change of the nervous system. In all fishes the fifth pair of nerves send branches to the various parts of the head, but in the blind fishes these branches are developed in a most wonderful manner, while their subdivisions take new courses and are brought *through* the skin, and their free ends become protected by fleshy papillæ, so as to answer, by their delicate sense of touch, for the absence of sight. At the same time the principle of retardation must have been at work and checked the development of the optic nerve and the eye (which probably exists externally in the young fish), while acceleration has caused other portions of the head to grow and cover over the retarded eye.

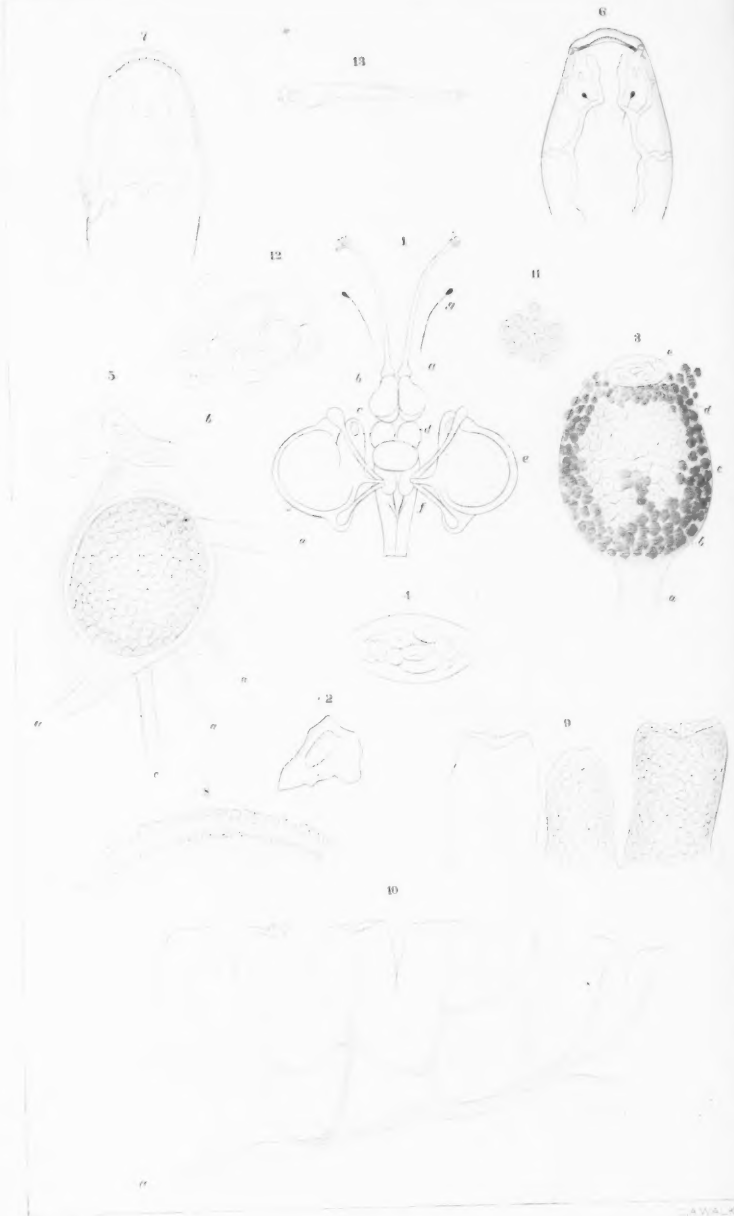
Now, if this was the mode by which blindness was brought about and tactile sense substituted, why is it that we still have *Chologaster Agassizii* in the same waters, living under the same conditions, but with no signs of any such change in its senses of sight and touch? It may be said that the Chologaster did not change because it probably had a chance to swim in open waters and therefore the eyes were of use and did not become atrophied. We can only answer, that if the Chologaster had a chance for open water, so did the Typhlichthys and yet that is blind.

If the Heteropygii have been developed from Cyprinodontes, how can we account for the whole intestinal canal becoming so singularly modified, and what is there in the difference of food or of life that would bring about the change in the intestine, stomach and pyloric appendages, existing between Chologaster and Typhlichthys in the same waters? To assume, that under the same conditions, one fish will change in all these parts and another remain intact, by the blind action of uncontrolled natural laws, is, to me, an assumption at variation with facts as I understand them.

Looking at the case from the standpoint which the facts force me to take, it seems to me far more in accordance with the laws of nature, as I interpret them, to go back to the time when the region now occupied by the subterranean streams, was a salt and brackish water estuary, inhabited by marine forms, including the brackish water forms of the Cyprinodontes and their allies (but not descendants) the Heteropygii. The families and genera having the characters they now exhibit, but most likely more numerously represented than now, as many probably became exterminated as the salt waters of the basin gradually became brackish and more limited, as the bottom of this basin was gradually elevated, and finally, as the waters became confined to still narrower limits and changed from salt to brackish and from brackish to fresh, only such species would continue as could survive the change, and they were of the minnow type represented by the Heteropygii, and perhaps some other genera of brackish water forms that we have not yet discovered.

In support of this hypothesis we have one species of the family, *Chologaster cornutus*, now living in the ditches of the rice fields of South Carolina, under very similar conditions to those under which others of the family may have lived in long preceding geological times; and to prove that the development of the family was not brought about by the subterranean conditions under which some of the species now live, we have the one with eyes living with the one without, and the South Carolina species to show that a subterranean life is not essential to the development of the singular characters which the family possess.

That a salt or brackish water fish would be most likely to be the kind that would continue to exist in the subterranean streams, is probable from the fact that in all limestone formations caves are quite common, and would in most instances be occupied first with salt water and then brackish, and finally with fresh water so thoroughly impregnated with lime as to render it probable that brackish water species might easily adapt themselves to the change, while a pure fresh water species might not relish the solution of lime any more than the solution of salt, and we know how few fishes there are that can live for even an hour on being changed from fresh to salt, or salt to fresh, water. We have also the case of the Cuban blind fishes belonging to genera with their nearest representative in the family a marine form, and with the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whole family of cods and their allies, to which group they belong, essentially marine. Further than this the cat fish from the subterranean stream in Pennsylvania belongs to a family having many marine and brackish water representatives. As another very interesting fact in favor of the theory that the Heteropygii were formerly of brackish water, we have the important discovery by Prof. Cope of the Lernæan parasite on a specimen of Amblyopsis from the Wyandotte cave; this genus of parasitic crustaceans being very common on marine and migratory fishes, and much less abundant on fresh water species.

Thus I think that we have as good reasons for the belief in the immutability and early origin of the species of the family of Heteropygii, as we have for their mutability and late development, and, to one of my, perhaps, too deeply rooted ideas, a far more satisfactory theory; for, with our present knowledge, it is but theory on either side.

EXPLANATION OF PLATES.

PLATE I.

[All the figures on this plate are from original drawings by Prof. J. Wyman.]

FIG. 1. Brain, nerves and organ of hearing of *Amblyopsis spelæus*: enlarged; *a*, olfactory lobes and nerves; *b*, cerebral lobes; *c*, optic lobes; *d*, cerebellum; *e*, organ of hearing, showing the semicircular canals, with the otolite represented in place by the dotted lines; *f*, medulla oblongata; *g*, optic nerves and eye specks.

FIG. 2. Otolite, enlarged.

FIG. 3. Eye, magnified (natural size one-sixteenth of an inch in length); *a*, optic nerve; *b*, sclerotic membrane; *c*, layer of colorless cells; *d*, layer of pigment cells (iris?); *e*, lens.

FIG. 4. Lens, enlarged and showing the cells.

FIG. 5. Eye, enlarged, showing the muscular bands, *a*, *a*, *a*, *a*; *b*, the lens pressed out of place; *c*, the optic nerve.

FIG. 6. Top of head, showing the canals under the skin, of the natural size. The two black dots and lines indicate the eyes and optic nerves in position.

FIG. 7. Top of head, showing the arrangement of the ridges of papillæ. Natural size.

FIG. 8. One of the ridges of papillæ from the head, magnified.

FIG. 9. Three of the papillæ from the ridge, still more magnified, showing the cup-shaped summit and projecting filament.

FIG. 10. A portion of the ridge magnified, and treated with acid, to show the arrangement of the nervous plexus supplying the papillæ with nerve filaments from a branch (*a*) of the fifth pair.

FIG. 11. Epithelial cells from the head.

FIG. 12. Epithelial cells from the body.

FIG. 13. A fish with eyes, found in the stomach of an Amblyopsis.

PLATE 2.

FIG. 1. AMBLYOPSIS SPELÆUS DeKay. Natural size.
1*a*. Stomach and pyloric appendages. Twice natural size.
1*b*. Scale, magnified.
1*c*. Abdominal cavity, showing position of stomach and single ovary. Natural size.

FIG. 2. CHOLOGASTER CORNUTUS Agassiz. Natural size.
2*a*. Stomach and pyloric appendages. Twice natural size.
2*b*. Scale, magnified.
2*c*. Abdominal cavity, showing stomach and single ovary behind the stomach. Twice natural size.

FIG. 3. TYPHLICHTHYS SUBTERRANEUS Girard. Natural size.
3*a*. Stomach and pyloric appendages. Twice natural size
3*b*. Scale, magnified

FIG. 4. CHOLOGASTER AGASSIZII Putnam. Natural size.
4*a*. Stomach and pyloric appendages. Twice natural size.
4*b*. Scale, magnified.

The scales figured on the plate are all from the second or third row under the dorsal fin. 4*b* is represented with the posterior margin *down*, all the others are represented with the posterior margin on the *left*. The natural size of the scales is given by the minute outline at the left of the figures above each scale; 4*b* is so small that the natural size can hardly be represented by the black dot.

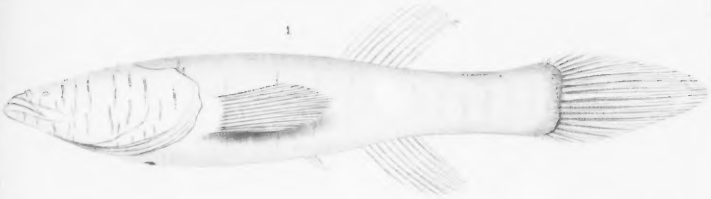
NOTE TO ARTICLE IN DECEMBER NUMBER, BY A. S. PACKARD, JR.

Since my article was printed, Prof. Cope's article entitled "Life in the Wyandotte Cave" has appeared in the "Annals and Magazine of Natural History" (London) for November. He enumerates the following articulates as inhabitants of this cave; "*Anophthalmus Tellkampfii*, and another species; two species of Staphylinidæ; Raphidophora; two species of flies; an Aranea-like and Opilio-like spider; a species of Pseudotremia; Cambarus pellucidus, an unknown aquatic Crustacean with external egg pouches, and a Lernæan (crustacean) parasitic on the blind fish. Of these one beetle (Anophthalmus), the cricket (Raphidophora), a fly, the Opilio-like spider, the centipede, and the blind crawfish, are probably the same as those found in the Mammoth Cave. Two beetles and two crustaceans are certainly different from those of the latter, and the centipedes are much more numerous. The Gammaroid crustacean found in the waters of the Mammoth Cave, and which is, no doubt in part, the food of the blind fish, we did not find; but some such species no doubt exists, as we found an abundance of a lively little tetradecapod crustacean near the mouth of a cave close by."

A NEW ERECTING ARRANGEMENT, ESPECIALLY DESIGNED FOR USE WITH BINOCULAR MICROSCOPES.

BY R. H. WARD, M.D.

FOR dissecting and other manipulations under magnifying powers, the simple microscope is awkward and unsatisfactory, and has been made to serve as a binocular only with low powers; but the superb field of the compound microscope has been comparatively little used for these purposes because few persons can work to advantage under an inverting arrangement, the erectors usually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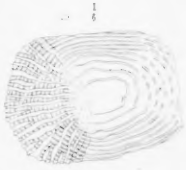
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furnished are not good, and the use, otherwise satisfactory, of a good objective as an erector has not as yet afforded the advantage of binocular vision. The simple expedient now proposed is designed to increase the usefulness of the stereoscopic binoculars in ordinary use by rendering them easily available for purposes which require an erect image.

Last summer I proposed, at the Indianapolis meeting of the American Association, to place, for certain purposes, an erecting objective below instead of above the regular objective of the microscope. Then, of course, the regular objective becomes the erector, and the accessory one below acts as the objective. This simple expedient, applied to Wenham's or other non-erecting binoculars, leaves little to be desired for the purposes of a dissecting microscope. As a simple contrivance, the lenses of a one-and-a-half or two-inch objective (preferably a solid or single-combination one) may be packed or screwed into the upper end of an adapter which when screwed into the nose-piece of the microscope carries them up close to the binocular prism, and into the lower end of which, lengthened more or less by two or three adapters of various lengths, the object glass may be screwed. A more elegant but scarcely more satisfactory arrangement is an adapter with sliding-tube adjustment which varies to the extent of an inch or more the distance between the erector and objective. Different powers and distances will of course be used according to the wants of different observers. The combination which has proved most convenient in my hands consists of a two-inch erecting lens close to the binocular prism, and a two-thirds objective at a distance, measured to its lowest end, of from three to four and a quarter inches below the erector; giving powers of ten to fifty diameters, and requiring a working distance between the stage and the binocular prism of four and one-half to five inches, which is quite practicable with large stands. A shorter working distance may be gained at a slight disadvantage. With a two-inch erector and four-tenths inch objective, powers of eight to fifty diameters can be secured without removing the binocular prism more than four inches from the stage; and with a one-inch erector and two-thirds inch objective a power of forty diameters is obtained with the binocular prism three and three-fourths inches from the stage. When, however, sufficient working distance cannot be obtained, the object may sometimes be placed upon the substage, or, oftener,

the substage removed and the body racked down so as to focus through the empty stage upon the table, a block or box, or an extemporized stage occupying the usual position of the mirror and illuminated by the mirror after the method suggested by Mr. James Smith. In this case it is desirable to increase the working distance between the prism and the object by varying the lenses employed. Thus a one-and-a-half-inch objective at from three and three-fourths to five and three-fourths inches from the erector will give powers of six to fifty diameters and working distance from prism of seven to ten inches. The erector may also be removed an inch or more from the prism. When this latter arrangement is to be used exclusively, placing the object at from eight to ten or twelve inches from the prism, as in many students' microscopes, the apparatus is further simplified by screwing a two-inch objective into the nose-piece in its usual position, as an erector, and screwing or sliding over it an adapter carrying a-one-and-a-half or two-inch objective from four to six inches lower down Some contrivance is required to illuminate transparent objects under the lower powers; but opake and translucent objects on a black ground can be dissected and manipulated with great facility.

The same erecting arrangement can be used in connection with monocular microscopes that have no draw-tube and therefore cannot use an erector in the usual position. It may also be used as a means of working Wenham's and other binoculars, with high powers. With powers of five hundred or one thousand diameters, however, it is still difficult to obtain good definition or to fully light both fields.

THE RATTLESNAKE AND NATURAL SELECTION.

BY PROF. N. S. SHALER.

For some years I have been teaching that the tail appendage of the rattlesnake was not to be explained on the doctrine of natural selection, inasmuch as it could contribute in no way to the advantage of the animal. It seemed to me quite clear that it was rather calculated to hinder than to help the creature in the race of life by warning its prey of its presence. Nor did it seem easy to ac-

count for its existence by supposing that it was used as a sexual call and had been brought up by natural or sexual selection for some such office. The burrowing habits of the serpents would seem to make sexual calls almost unnecessary and there is no evidence to make a reasonable basis for belief that rattlesnakes exercise any such choice in pairing as would lead to the development of this very singular appendage. Last summer, however, I had a long desired opportunity of examining a little into the habits of the rattlesnake and obtained some results which have served to shake my confidence in the opinions I had held as to the usefulness of his rattle. The observations are, as it will be seen, rather insufficient for a determination of the points in question, but it may be long before I am able to add to them, so I give them now hoping that some one with better opportunities for studying the ways of this interesting creature may either confirm my opinion or refute it.

The first and only living and active rattlesnake which I met on a carriage journey of some months' duration made during the past summer through that part of the Appalachian chain where these serpents most abound was in the middle of a road near the Kishicoquillas Valley, Pennsylvania. As the sound of my carriage disturbed the surly fellow in his pleasant basking place in the dusty way, he begun to sound his warning when we were over a hundred feet from him. Although quite accustomed to the sound, having had specimens captive for months at a time, I mistook it for that made by our "locust," the *Cicada rimosa* Say, nor did I perceive the error until my companion, Mr. A. R. Crandall, called my attention to the serpent when we were within forty feet of it. My wife and child, a little girl of eight years, who were in the carriage also mistook the noise for that made by the Cicada, which was abundantly familiar as it had been for a long time the most accustomed sound heard while we were travelling through the wooded mountain country.

I have found that the note of the rattlesnake is recognized by many persons as indistinguishable from the sound made by the Cicada. Professor Brewer, whose long experience in the service of the California Geological Survey gave him quite unrivalled opportunities for becoming familiar with the sound made by this reptile, tells me that he was on one occasion at least in great danger of being bitten by one of these animals on account of having

supposed that its persistent rattle was only the whirring of a locust. The range in pitch in the rattling sound of the snake is quite great; it is even difficult to understand how sharp it can be from a study of the sound made by the animals tamed by captivity, but at the same time the note of the locust is also very variable so that one is not able to discriminate by this means. The reader will doubtless have caught the main point towards which these facts so plainly tend, namely, that the imitation of the note of the locust may possibly be of high value to the rattlesnake. The Cicada furnishes the most satisfactory mouthful to many of our birds. Almost every observer of the life of our woods and fields, has seen a bird spying around a branch whence came the whirring of a locust; suddenly there would be an end of the monotonous sound, and a moment after the bird would be seen, beating the wings off the insect by pounding it against the ground. It is quite evident that any animal which preyed upon birds would gain a decided advantage from being able to imitate the sound made by the creatures on which the birds fed, so that we can well imagine that those snakes endowed with the power of attracting birds would be the best fed and multiply the most rapidly. From this point of view we can also understand how it is that birds have been seen fluttering around a rattlesnake without calling into play the unreasonable agency of fascination; the bird in this case being in search of his food and decoyed into the range of the serpent's spring.* It is a well known fact that birds, even those which have the best determined notes, are easily misled by sounds which approach, even though imperfectly, the calls of their species or the sounds of their prey, so that the imperfections in the note of a rattlesnake when considered as an imitation of the Cicada cannot count much as an argument against this view.

If this view be correct, then we must regard the rattle of the rattlesnake as a useful appendage, and not an instrument calculated to do it injury by warning its prey of its presence.† But it

* I had an opportunity, recently, of seeing a living Cobra di Capello in a state of excitement. The first impression was how entirely unlike any other serpent it was. The broad, flat banner-shaped neck upon the slender staff of the body would readily lead one to suppose that it was something very different from a snake. I can readily imagine that animals which had learned, by selection or otherwise, to shun creatures shaped like serpents, would be easily misled by the strange shape of the cobra and fail to avoid it or even be attracted towards it by the curiosity which animals often show to see closely or even smell any strange object.

† Rattlesnakes of the genus Crotalophorus make little or no noise with the imperfect

is by no means so easy, even if we allow all that can be claimed for natural selection, to account for the development of this appendage. The following seems to me the most satisfactory conception of its evolution, looking at the matter from Mr. Darwin's point of view. It is a fact well known, doubtless, to those who have observed serpents, though I find no mention of it in the works I have consulted, that many serpents, when in a state of excitement vibrate the end of their tail just as the rattlesnake does.* This movement is likely enough the same in character as that which occurs in the hinder part of the spinal column among higher animals under excitement. The wagging of the dog's tail is a rhythmical movement of essentially the same character as the movement of the rattlesnake. Taking the same line of argument as that adopted by Mr. Darwin with regard to the monthly phenomena observable among the mammalia, it could be claimed that the tendency to move the tail was explicable on the following grounds. During more than half the lifetime of the group of vertebrates, from the point of their presumed origin at the close of the Silurian down to the present day, the caudal portion of the body was used as the propelling agent. Fishes, with slight exceptions, propel themselves by a reciprocating movement of the tail. All conditions of excitement at once manifest themselves in the violent movement of this part of the body. Whether in flight or chase or under the influence of sexual excitement, this movement is the important element of success. It is by no means surprising that the motion which was for ages the point which natural selection operated most intensely, for those forms which had the capacity for making this alternate movement of the tail with the greatest rapidity would be most successful in flight or chase, should have survived its usefulness and remained as a mere feature of expression in most of our animals. It may be remarked in

rattles of the tail. In this genus, therefore, there could have been no advantage derived from imitation. It may be said, however, that the rattles which have little functional value in this genus, if making a sound be their real function, are even more irregular in number and shape than in the Crotalus. The truth probably is that there is an inherent tendency to form rattles in this group of serpents and these structures are seized upon by natural selection and made functional.

*Since the above matter was put in type, I have learned that Prof. Jeffries Wyman made a communication to the Boston Society of Natural History, concerning the occurrence of this movement in the tails of snakes other than the rattlesnake, some two or three years ago. I have failed to find any notice of the communication in the Proceedings of the Society, though there can be no doubt that this eminent naturalist should be credited with the priority on this point.

passing that the obstinate survival of the tail among the vertebrates may be accounted for by the intense bodily inertia, if we may so call it, which causes the energy of survival of useless structures to be proportionate to the length of time which they have been of use to the groups to which they belong. It is natural enough that a part of the body situated at one of the regions of manifold relations as the tail is, and unappropriated to any special function, should be put to use in various ways, as a prehensile instrument by some monkeys and other animals, or a building tool by the beavers, as a fly-brush by many others, etc.

Mr. Herbert Spencer has already suggested that the wagging of the dog's tail and similar movements of that appendage is in fact an escape of nervous force restrained from other modes of expression at the moment. Looking at the matter from this point of view, which is doubtless quite satisfactory, we may reconcile it perfectly with the views which have just been presented by supposing that the ancient and no longer functional channel of escape for nervous force, the tail, has remained the way of outlet for the suppressed energy of the animal. The older the channel the less easy it is to close it either by volition or by natural selection.

Be the cause of the persistence of the tail and its movement what it may, we are still justified in assuming as the starting point, that the progenitor of the rattlesnake had the alternating motion of the tail common among snakes. It is the opinion of some herpetologists that the rattles are the remains of the skins successively shed by the animal. The rate of development of the rattles, together with the fact that the skins of some serpents are more imperfectly detached from the region about the tail than at other parts of the body, makes this view very probable. Let us suppose that we had a group of poison-fanged serpents, accidentally tending to keep the tail skin in the peculiar fashion of rattlesnakes and that in some of these it was persistent enough to make the whirring sound of the Cicada when the tail was rapidly moved under excitement. These would survive and breed the most surely and so that feature would become hereditary. The great variability in the number of rattles in the different forms of rattlesnakes and the late time of their development, even among those which differ in no other regard, would seem to indicate that this structure has not yet been firmly fixed by long inheritance.

The reader will please not suppose that because I have boldly

followed the lead of the most advanced of the champions of natural selection that I am convinced of its sufficiency as an explanation of the great diversities which exist among animals or of its being sufficient basis for an explanation of the snake's rattle. But having been driven step by step from a decided opposition of the whole theory and compelled to accept it as a *vera causa*, though I think one much more limited in its action among animals than Mr. Darwin believes, I feel it to be my duty to examine every one of those points upon which I have relied for evidence against it.

It must be confessed that the case of the rattlesnake seems to me no longer the bar to the acceptance of the theory it once did.

REVIEWS AND BOOK NOTICES.

Norwegian Zoology.* — The thoroughness and zeal shown by the Scandinavian naturalists in working up minutely the fauna of their shores is remarkable. While the land animals and plants of the country of Linnæus and Fabricius have been most zealously described, of late years no region has been so thoroughly explored with the dredge and net as the coast of Denmark, Norway and Sweden. We are also indebted for nearly all our most accurate knowledge of the natural history of Greenland, Iceland and Spitzbergen to the hardy and adventurous sons of the Norsemen, who first visited those islands for discovery and conquest. And it is a fact that in those countries where the land is most barren in organized life, the most valuable knowledge of biology has been acquired. With a few exceptions no one has done more to advance zoology in the highest sense than Professor Michael Sars. The marine zoologists of our own country owe him a peculiar debt of gratitude, for his writings have been a constant source of information, and better still a stimulus to do more thorough and lasting work.

The present memoir consists of detailed and beautifully illustrated descriptions of new additions to the marine fauna of the bay of Christiania. The figures have been drawn by Dr. G. O.

* Bidrag til Kundskab om Christianiafjordens Fauna. II. Af Michæl Sars. (Prepared from his manuscript by his son, G. O. Sars.) Christiania, 1870. 8vo. pp. 114, with six plates.

Sars, one of the most eminent of the younger European zoologists, and a zoological artist of unusual skill.

The chief interest of the book is in the accounts and figures of the curious crustacean parasites found living on worms. These are degraded water fleas (Copepoda), like the Lernæans found living on the gills of fishes. The Danish naturalist Kröyer, recently deceased, was the first, we believe, to discover one of these parasites on a worm (Polynoë). Keferstein, a German naturalist, afterwards detected several similar forms, and more recently Steenstrup, Claparède and others have found a considerable number on different worms. These discoveries form a new chapter in the intricate subject of parasitism, and open up new relations in the study of biology.

New Galapagos Birds.*—During the course of seven years' explorations in the greater part of Central America, the Cordilleras of the Andes in Columbia, Ecuador and Peru, Dr. Habel found time to visit the Chinca and Galapagos Islands. While he paid particular attention to the natural and physical history of these regions, he did not neglect the ethnology and meteorology of the countries he visited. He has returned with large collections stored up in New York, and we trust he may get time to arrange and publish the results of his travels. Meanwhile the birds of the Galapagos Islands have been identified, and in this article, a list of thirty-seven species of birds collected by him is given, with illustrated descriptions of seven new species. The authors state that they "are preparing for publication a memoir on the avifauna of this group of islands, in which [they] propose to embrace what has previously been recorded on this subject, as well as the results of Dr. Habel's arduous investigations."

Recent British Ostracodes.†—Whoever attempts the difficult and wearisome task of studying and describing the numerous shelled entomostraca which swarm in our pools, ponds and streams, and also in the sea, will find the occasional papers of Mr. Brady invaluable, while the present is a work ranking with the elaborate

*Character of new species of birds collected by Dr. Habel in the Galapagos Islands. By P. L. Slater and O. Salvin. (From the Proceedings of the Zoological Society of London.) May, 1870. 8vo. pp. 6, with cuts.

†A Monograph of the Recent British Ostracoda. By George S. Brady. (From the Transactions of the Linnæan Society, vol. xxvi. (no date) 4to. pp. 142, with 18 plates.

volume of Baird, and the more thorough memoirs of Lilljeborg, Fischer, Zenker, Claus, Sars, and others. The classification is that proposed by G. O. Sars, son of the distinguished Norwegian zoologist, Prof. Michael Sars, in his "Oversigt af Norges marine Ostracoder" published in 1865. The Ostracoda are represented by the little two shelled water fleas, about half a line or less in length, which swim over the bottom or creep over submerged plants. As remarked by the author, "the geographical and bathymetrical distribution of the Ostracoda is a matter of the greatest interest as illustrating the probable condition under which the various fossiliferous strata have been deposited." We might also add that the Ostracoda are found in the lowest fossiliferous strata, in company with the Trilobites and Nebaliads. So that a profound knowledge of the living species is absolutely necessary for the correct appreciation of some of the earliest traces of life on our globe.

THE AMERICAN ENTOMOLOGIST.— I regret to state contrary to announcement a year ago, that this magazine will not be continued during the coming year. The cost of publishing a paper so profusely illustrated with original figures is great, and the publishers, Messrs. R. P. Studley and Co., have lately concluded to discontinue it, as they have not met with sufficient financial encouragement. I have, however, since they so decided, purchased from them all the illustrations, and all interest in the magazine, and hope at no very distant day to recommence its publication myself. Meanwhile I take this means of thanking the many subscribers who, during the year, have sent in expressions of encouragement and appreciation, or who have signified their intention of renewing subscription. I shall ever be glad to hear from them on entomological subjects, and to render them what little service lies in my power.—C. V. RILEY, *St. Louis, Mo., December* 10, 1871.

BOTANY.

DISMISSAL OF THE LATE BOTANIST OF THE DEPARTMENT OF AGRICULTURE.— *Editors American Naturalist.* DEAR SIRS:—I have to request that you will place before the readers of the AMERICAN NATURALIST the correspondence herein enclosed.

Dr. Parry was thought to have performed the duties of Botanist to the Department of Agriculture to the entire satisfaction

of the previous Commissioner. His extraordinarily abrupt dismissal upon the incoming of the present Commissioner, following a course of vexatious treatment to which, he states, he was subjected by his Chief Clerk, does not seem calculated to win the confidence of scientific men in the present administration of a department in which they naturally feel much interest.

Very respectfully yours,

ASA GRAY.

DEPARTMENT OF AGRICULTURE,
Washington, D. C., September 27, 1871.

Hon. F. WATTS, *Commissioner of Agriculture.*

SIR:—In order to enable me to comply strictly with the regulations of this Department in regard to ordinary correspondence in connexion with my official duties as botanist, I respectfully ask to be furnished with written instructions on the following points. 1st. Should letters addressed to me personally, as botanist of the department, imparting or requesting information on botanical subjects, be answered and signed by me personally as botanist, or in the name of the Commissioner? 2d. In sending botanical specimens to be named, or in returning such as have been sent to me to name, should the accompanying letter be signed by myself as botanist or by the Commissioner?

Having heretofore exercised my own discretion in this matter, with due regard to the scientific interests of the department and to facilitate the business of my division, I desire to avoid any future misunderstanding by receiving definite written instructions on these points for my guidance.

Respectfully yours,

C. C. PARRY, *Botanist Agr. Dpt.*

DEPARTMENT OF AGRICULTURE,
Washington, D. C., September 27, 1871.

C. C. PARRY, *Esq., Washington, D. C.*

SIR:—Your services as botanist of this Department will not be required after this date.

I am respectfully,

FREDERICK WATTS, *Commissioner.*

DEPARTMENT OF AGRICULTURE,
Washington, D. C., September 27, 1871.

Hon. FREDERICK WATTS, *Commissioner of Agriculture.*

SIR:—I have the honor to acknowledge your letter of this date informing me that my "services as botanist of this Department will not be required after this date," for which I sincerely thank you.

I respectfully request that you will designate some person from the de-

partment to-morrow to be with me in selecting my private property, books, etc., from that belonging to the Department.

Respectfully yours,

C. C. PARRY, *Botanist Agr. Dept.*

To the Honorable JUDGE WATTS,

U. S. Commissioner of Agriculture, Washington.

The undersigned, botanists, well acquainted with Dr. C. C. Parry, and having a high opinion of his ability, industry, entire probity and honorable character, as well as of his peculiar qualifications for the position, acting upon their view of the best interests of the science they represent, and sincerely believing that his dismissal must have taken place under some misapprehension, hereby respectfully solicit that the Commissioner would take into consideration the propriety of re-appointing Dr. Parry to the position of Botanist in the Department of Agriculture.

JOHN TORREY,
ASA GRAY,
WM. H. BREWER, *Prof. Agriculture in Yale College.*
DANIEL C. EATON, *Prof. Botany in Yale College.*

Harvard University Herbarium, November 22, 1871.

P. S. — A copy is forwarded to Messrs. Watson, Engelmann, and Canby, for their signatures.

DEPARTMENT OF AGRICULTURE,
Washington, D. C., November 27, 1871.

To Prof. ASA GRAY.

DEAR SIR: — Prof. Henry this morning placed in my hands the note of Profs. Torrey, Brewer, Eaton and yourself, asking me "to consider the propriety of reappointing Dr. Parry to the position of Botanist in the Department of Agriculture." The respect which I must necessarily have for a suggestion coming from such a source induces me carefully to review my action in the matter of Dr. Parry's removal; and my conclusion is, that my own self respect and especially the interests of this Department, forbid that I should reverse that which I did with care and reflection. I did not, to Dr. Parry himself, assign any reason for his removal, simply because he did not afford me any opportunity to do so. I did not see him afterwards, but I should add that it was quite acceptable to me that I was not called upon to assign reasons which it would have been as disagreeable to me to utter as for him to hear. Nor do I now desire to say any thing about Dr. Parry that might disparage him in the estimation of his friends.

I am, most respectfully, your ob't. servant,

FREDERICK WATTS.

Cambridge, Mass., November 30th, 1871.

To the Hon. FREDERICK WATTS, *U. S. Commissioner of Agriculture.*

SIR: — I have to acknowledge your favor of the 27 inst. in reply to the

memorial addressed to you by Professors Torrey, Brewer, Eaton, and myself. It still appears to me that the friends of Dr. Parry are entitled to know the reason of his summary dismissal by you,—all the more so that your letter intimates, without directly asserting, some moral delinquency on his part. I am still so confident that you must have been misled, that I respectfully ask leave to print your letter to me along with the memorial to which it is a reply; in case you still decline to furnish the charges upon which Dr. Parry's dismissal was grounded.

I am, sir, respectfully, your obedient servant,

ASA GRAY.

DEPARTMENT OF AGRICULTURE,
Washington, D.C., Nov. 8, 1871.

To Professor ASA GRAY.

DEAR SIR: — Yours of the 30th of November was handed to me yesterday by Professor Henry. If it were not that you say that my former letter to you "intimates without directly asserting some moral delinquency" on Dr. Parry's part, I would content myself by saying that my judgment dictated to me the propriety of Dr. Parry's removal. But I have concluded to put you in possession of the whole subject.

When I took charge of this Department, my first duty was to look into and to understand the divisions of subjects which make up its whole, the work that had been done, and the character and competency of each individual who had charge of that work. Among the divisions was that of the Botanist, with Dr. Parry in charge of it. My attention was called to the inquiry, how and to what extent the work of this division conduced to the practical operations of the Department. I found that nothing at all had been done by Dr. Parry beyond his attention to the preservation of the herbarium. This Department is designed to render the developments and deductions of science directly available to practice, that farmers and horticulturists may be benefited by them. The principles of vegetable physiology, their relations to climate, soils, and the food of plants, and the diseases of plants, which are principally of fungoid origin, it is clearly the duty of a botanist to investigate. If possible, he should throw some light upon the origin and condition of growth of the lower orders of cryptogamic botany. This is a domain into which I could not discover that Dr. Parry had ever entered, so far as his practical work here gave any indication. The routine operations of a mere herbarium botanist are practically unimportant.

In the course of my investigation, my attention was also drawn to letters written by Dr. Parry, which I deemed objectionable because of his mode of expression, wanting in perspicuity and not creditable to the Department. These things, and what I also learned that my predecessor had signified to Dr. Parry, to the effect that his letters should be submitted to him and for his signature before they were sent away, induced me to direct my chief clerk to have a conversation with Dr. Parry, and to say to him that, as the head of the Department, I was responsible for

whatever emanated from it, and that all letters on official business must be sent open to me, for my signature and frank. I returned with this message a sealed package for which my frank was asked. At another time I returned to Dr. Parry by my chief clerk, a letter which he had written and which I did not think proper should be sent, and which the Doctor passionately tore up and threw into the waste basket. This he subsequently apologized for to the gentleman he had thus insulted. On the 25th of September, after these various conversations between my chief clerk and Dr. Parry, he wrote another letter addressed to "My Dear Doctor." It had no other designation. For whom it was intended, I did not learn, or if I did I have forgotten. It concluded, "yours, 'officially,' C. C. Parry." I wrote on this letter, "This is not very intelligible in its last sentence; besides, the Botanist can sign no official letters. What his 'official' means I do not understand, but under the circumstances, I think it is intended for impertinence." It then occurred to me that I would dismiss Dr. Parry, but held the matter under advisement for two days, until the 27th of September, when I received a note from him, in which he requested me to furnish him with *written* instructions (underscoring the word), and which contained two queries respecting letters from the Department. I did not think that he was in want of the information he asked for, and my answer to his note was that the Department did not longer require his services. My conviction was then, and is now, that whatever may be the qualifications of Dr. Parry as a botanist, he was not competent creditably to discharge the duties which should devolve upon him in connection with this Department, and therefore, without passion or prejudice, I determined to dismiss him.

A word in reply to your suggestion about printing my letter and your memorial. I decline to be a party myself to any such proceedings. But if you will take the whole responsibility of it, I shall never complain that you have violated a confidence which I never intended to impose.

I am, very respectfully,

FREDERICK WATTS, *Commissioner of Agriculture.*

BOTANIC GARDEN,
Cambridge, Mass., December 11th, 1871.

To the Hon. FREDERICK WATTS, *U. S. Commissioner of Agriculture, Washington, D. C.*

MY DEAR SIR,—I have to thank you for your letter "Nov" [Dec.] 8th, in response to mine of Nov. 30.

You will permit me to remark, that the dismissal, without an hour's notice, of Dr. Parry from a position the duties of which he was thought to have performed acceptably to your predecessor, must of itself, if unexplained, cast an injurious reflection upon his character or conduct. Then your letter in reply to the memorial which solicited his recall, stating that the reasons for such dismissal were of a nature which it would have been as disagreeable for you to utter as for him to hear, and that you "do not now desire to say anything about Dr. Parry which might dis-

parage him in the estimation of his friends,"—all this certainly conveyed to my mind the conviction that some serious delinquency had been charged. It is with satisfaction, therefore, that I have read your letter now before me, obligingly written "to put [me] in possession of the whole subject." I learn from it that the reasons for Dr. Parry's summary and ignominious dismissal relate to some details of form in the mode of conducting official botanical correspondence, —to a momentary loss of temper in the presence of one of your subordinates (evinced by the mode in which he destroyed a letter of his which had been returned to him to be cancelled), and for which he duly apologized,—to the subscribing of a letter addressed familiarly "My Dear Doctor" [evidently some botanical correspondent] by the phrase "yours officially,"—that in some letters you found "his mode of expression wanting in perspicuity "(a fault into which more practised writers may sometimes fall),—and finally, that you did not discover in Dr. Parry the kind or degree of botanical qualifications for the post which you were entitled to expect, and deemed the services of "an herbarium botanist" practically unimportant.

As your letter has relieved my own mind from a painful anxiety upon this subject, it may have the same effect upon others, upon whose minds also your action had left the alternative of supposing, either bad conduct on the part of one hitherto highly esteemed, or of very hard usage towards him (it was thought through some misrepresentation of him or some misapprehension of yours). I think it proper and just, therefore, to make use of the permission you grant, and to take the responsibility of making public, in scientific circles, first, the correspondence between Dr. Parry and yourself, and second, that between ourselves.

I am, very respectfully yours,

ASA GRAY

EXTRACTS FROM REPORTS OF THE BOARD OF TRUSTEES OF THE AGRICULTURAL COLLEGE of Pennsylvania, made by the Hon. FREDERICK WATTS, 1865, 1868: — examples of "perspicuity," etc.

"If science and learning be useful at all, where can it tell with so potent an influence, as where it deals with the operations of a farm, which embrace a great number of mechanical and chemical forces, and involve the necessity for searching after philosophical truth?"

"The individual members of the Board of Trustees, have labored assiduously for several years to establish a school, where an education may be obtained which will qualify farmers' sons intelligently to pursue their fathers' business. They have been influenced by the belief that this object cannot be attained at any of the literary colleges of our State; that the knowledge and habits which they impart disqualify youth for such pursuits, and thereby defeat the object of the parent, and add nothing to the interests of agriculture."

"Our experience teaches us, that a farmer's son, graduated in such an institution, finds no place, ever after, in the domestic circle of his family:

he is actually driven, by his education, into the necessity of resorting to some neighboring town, in pursuit of a learned profession, where he soon forms habits of idleness and intemperance; and the result is, that the father not only loses the expenses of his education, but the son himself."

"These farms will all differ essentially in the character of soil and situation; and will be conducted under the eye of a skilful Professor of Agriculture for the purpose of testing and developing the thousand mysteries which now cloud the knowledge of the farmer. These experiments carried on under the direction of a scientific observer, who will constantly keep note of the weather, *the signs of the Zodiac*, the application of manures, and all the various actual and supposed influences which affect the growth of plants; and this, too, at three different points of the State, and upon different soils, cannot fail to produce an amount of information exceedingly valuable, and which could never be collected by individual exertion. Until now our Institution has never had the power of prosecuting these inquiries; but we now start upon a new career girded about with the strength of sufficient means, and we hope with great certainty to soon make it tell upon the Agricultural interests of the State."

Potatoes Growing Above Ground. — I send you herewith, what appears to me to be a rather uncommon freak of nature. I remember an old ballad which ran something like this—

"They plant potatoes in the fall
Over there, over there.
And they dig them tops and all
Over there, over there,"

but I never knew of any authority for the potatoes growing on the stalk above ground until I saw it in the specimen I send. There were found in our potato field yesterday several stalks of potatoes having from six to twelve or more little potatoes on them, from the eyes of which are shooting the regular leaves. They seem in these specimens to grow from the axils, but in some other specimens they seem to be enlargements of the leaf-stem itself. — B. D. Eastman, M.D.

Helenium tennifolium. — Specimens of this plant were presented by Dr. Foreman, having been found by him growing about three miles northwest of Baltimore, in the neighborhood of some cotton mills. As it is a native of the extreme southwestern States of Arkansas, Louisiana and Texas, it is believed that its seeds have been introduced in cotton bales from a southern port. The plants observed were few in number, as if recently established, but were in vigorous growth and have made abundance of seeds.— *Proceedings Maryland Academy of Sciences, Nov.* 6, 1871.

ZOOLOGY.

CARBONIFEROUS REPTILES OF OHIO.—Prof. Cope made some observations before the Philosophical Society at Philadelphia on the extinct Batrachian Fauna of the Carboniferous of Linton, Ohio, based on studies of materials obtained by Prof. S. J. Newberry, director of the Geological Survey of Ohio. Twenty-seven species had been discovered up to the present time, twenty-three of which were referred to the following genera. Pelion Wyman, 1; Sauropleura Cope, 3; Tuditanus Cope, 4; Brachydectes Cope, 1; Oestocephalus Cope, 6; Cocytinus Cope; Molgophis Cope, 1; Phlegethontia Cope, 2; Colosteus Cope, 3; Eurythorax Cope, 1.

Tuditanus, Cocytinus and Phlegethontia were described as new genera. The first represented Dendrerpeton Owen, but possessed thoracic shields. Plegethontia embraced slender snake-like forms without armature, ribs or limbs, and was allied to Molgophis. Cocytinus was defined as a branchiferous animal somewhat resembling Necturus, but without fore limbs and well ossified vertebræ.

Oestocephalus was defined as having the three pectoral shields, weak posterior limbs only present, head lanceolate; ventral armature consisting of closely packed osseous rods arranged *en chevron*; spines of the vertebræ fan-shaped. Three new species were described, one of which was the smallest of fossil Batrachia, being scarcely four inches long and represented by beautiful specimens. Two new species of Sauropleura, three of Tuditanus, one of Cocytinus, two of Phlegethontia and one of Colosteus (*C. pauciradiatus*) were added to the system. *Eurythorax sublævis* Cope was a large form of four feet in length with the pectoral shield very broad and nearly smooth.

Pelion and Tuditanus were pointed out as the broad-headed types. It was stated in conclusion that no reptiles proper had been yet discovered in the coal measures and that Sauropleura looked much like a Lacertilian with its long limbs, neck, etc., yet it had the armature of the belly and other structures of the Batrachia. This class has then forms resembling the serpents (Molgophis), lizards (Sauropleura) and crocodiles (Labyrinthodon) among true reptiles.

NOTE ON THE PRAIRIE DOG.—The graphic account of the habits of *Cynomys ludovicianus* given by Prof. Jillson in the NATURALIST for March, 1871, refers to the small amount of water used by it.

Our experience with a pair which were domesticated in my laboratory for a month, agrees with his, so far as regards the water; when offered it was either refused or merely tasted. Of milk, however, they were very fond, and drank from the same dish with a cat, lapping it up greedily and seldom stopping while any milk remained; in less than fifteen minutes, however, a looseness of the bowels always appeared, which continued for a day or two. In uttering their peculiar cry, they seemed to stiffen the whole trunk and "rear" into a very comical attitude. Curiously enough, they not only burrowed, but were vigorous climbers, would run up my legs and get upon my shoulders and even head; but they seemed to have little power of estimating height, for they continually tumbled from the chairs and tables, often striking upon the tip of the nose, whereupon they made comical passes in front of the nose with the front-paws; one of them finally was killed by falling from a window, to the seat of which he had climbed by means of a table-leg. The other has been described, and I may hereafter give some account of its structure. — BURT G. WILDER.

ORNITHOLOGICAL QUERY. — I have seen a partially albino Robin, in which numerous pure white feathers are scattered through the otherwise normally colored plumage. This is of very common occurrence, but the circumstances under which the specimen was secured open an interesting question. It was one of a flock in which were several partial albinos like itself, and one wholly white bird. Is it probable that, as suggested by Mr. Glover, these speckled birds were the offspring of the white one and a normally colored mate? — ELLIOTT COUES.

BIRDS FOUND BREEDING IN THE CATSKILL MOUNTAINS. — During a visit to the Catskill mountains, in the second week of July, I found the following birds breeding there: — *Regulus satrapa*, *Dendrœca coronata*, *Sitta Canadensis*, *Troglodytes hyemalis*, *Junco hyemalis*, *Dendrœca virens*, *D. Canadensis*. The last four birds are common throughout summer in all the higher hills of Ulster and Sullivan counties, and the mountains of Pennsylvania. The golden-crested wren, I noticed only on the summits of Round Top, and one or two others of the highest peaks. On the eighth of July, I saw several young birds, apparently not many days from the nest. They were attended by their parents, and hid themselves from observation, amid the densest hemlock boughs. At

times, the old birds uttered a lisping sort of warble, beginning like that of *Dendræca striata*, but winding up with a few sprightly notes, similar to those of *D. virens*. The young had no notes, save the usual faint chirp. What is the southernmost observed breeding locality of this bird?

Petrochelidon lunifrons is the commonest swallow in the Catskills, far outnumbering all the other species combined. It breeds in great numbers under the eaves of every barn and deserted house. In no other eastern locality have I noticed it in such great abundance as in these mountains. — T. Martin Trippe.

Fishes as Surgeons. — In walking through the long dank grass of the forest, an almost imperceptible, minute sort of tick attached themselves to the ends of our trousers, and from thence up our legs and buried themselves in the flesh, causing a most annoying sensation of itchiness. The whole party soon became victims to the irritation of this little pest, and scratched and exclaimed without measure. One of the Caribs, on hearing the cause of our vexation, said that the remedy was near, advising us to go without one moment's delay and lie down in the river, and that there was a small fish in the creek which would almost immediately extract the tick if it had not burrowed too far into the flesh; we all did as I fully expect you to do, gentle reader, on hearing this novel style of surgery, burst out into uncontrollable fits of laughter; but on Mr. C— and the manager's assuring us that the blacks only spoke from long experience, and that they themselves had more than once proved the efficacy of the cure,— warning us at the same time that the tick, if not soon extracted, would become a very severe sore; we at last, but without one atom of faith in the experiment, assented to the proposal, and commenced to undress without further opposition.

We bathed, and then in compliance with the Carib's directions, lay down quite still in the shallowest part of the stream. In a few moments, I felt something very sharp strike against several parts of my body; cautiously raising my head, and looking down towards my legs I saw a swarm of very small fish, wriggling and swimming around me, continually bobbing their little heads at my person, and readers, ridiculous, incredulous as I fear my story will sound in the ears of the unlearned, positively the fish not only picked off the tick which were outside the flesh, but actually extracted those which had burrowed beneath the skin.—*Exchange.*

A Sea Bird Inland.—The cold, northeast storm of the past few days brought us a rare visitor in the shape of the Little Auk, *Mergulus alle* L. Two individuals were captured in full winter plumage and plump, though with empty stomachs. Their occurrence thirty miles inland is somewhat remarkable. Allen records the capture of a single specimen at Greenfield, Mass, on the Connecticut, and Linsley places the species among the birds of Connecticut on the strength of one captured near Martha's Vineyard. It is found on the coast of New Hampshire, New York and New Jersey in winter, and was therefore to have been expected on our own, but this is its first appearance in Middletown. — G. Brown Goode, *Middletown, Connecticut, November 18th.*

[The same storm drove a lot of the little auks to Middletown, Mass., and large numbers were taken along the coast of Massachusetts. Maynard says he has seen it in Florida. — Eds.]

Note on Hemirhamphus (Richardi?)—An ichthyological friend requests us to make a note of the unsuspected abundance of this fish on the North Carolina coast. It occurs at certain seasons in immense numbers, swimming near the surface in schools so large and dense that specimens may rapidly be secured by simply jerking a naked hook through the water. — Elliott Coues.

Occurrence of the Orchard Oriole in South Carolina. — Dr. Coues, in his "Synopsis of the Birds of South Carolina," enumerating the Icteridæ, says of the Orchard Oriole (*Icterus spurius*), "*rare*; chiefly migrant; some probably *breed*." My own observations in this State differ somewhat.

On the 28th of June, this last spring, and a few days after my arrival at Camden, I happened to be walking across one of the public squares of the town, when among the songs of many other birds, I thought I distinguished the note of the Orchard Oriole, and the next moment caught sight of the familiar but unexpected person of this little dweller of our northern orchards. Flitting among the branches of a tree near by, every moment or two he sang his cheerful song, and while I stood watching, as he busily searched among the leaves for insects, his more sober partner joined him, holding in her bill a worm, which, however, she soon carried off, flying towards the other corner of the square. I followed, and in a few minutes after discovered the pendant nest,

hanging from one of the lower boughs of a small oak and not more than fifteen feet from the ground; drawing the limb down to me, I found that it contained four nearly fledged young. While I was engaged in examining these, the two old birds kept up a terrible chattering, flying so near, that at one time I thought they were about to attack me. One of the young ones I tried to rear in a cage, but failed in my attempt.

Since then, I have discovered five other nests, three of which contained half fledged young, the other two had been but recently deserted, and in one case, I saw the parent birds feeding the fledglings in the neighborhood of the nest.

These nests were all found from the 28th of June to the 19th of July, and were with one exception in the thickly inhabited portions of the town and on the edges of the public squares. I do not doubt but that if I had made especial search for them, I should have discovered many more; for in various parts of the town, I saw the black and chestnut of their plumage shining amidst the topmost boughs and heard their clear and pleasant songs sounding in every direction around me. I counted fifteen pairs of these birds, of which I shot four. They seemed nearly as familiar as I have noticed them at the north, and from all I can learn are thought one of the common species of birds at this place, and are called *Gold-finches*, why, I cannot conceive, as the title would more nearly apply to the Baltimore Oriole. These facts would, I think, prove them not *rare*, at least in this portion of the state, and establish the fact of their *breeding* here.

But, from Dr. Coues not having discovered a nest of this species at Columbia, during two years' observations at that place, which is not more than thirty miles distant, I am inclined to believe that the Orchard Oriole is very partial to certain favored localities, resembling in this respect the Baltimore bird, which most certainly seems to prefer one place to another, although it may be but a few miles distant. Also, during three days spent at a small village, but eleven miles from Camden, I neither saw nor heard one, from the time I left the precincts of the town until my return, although I looked and listened for them especially, and on enquiry found that the residents considered the Gold-finch quite a rare bird in their portion of the country. Audubon speaks of this species as not uncommon in Louisiana during the breeding season.

Of the four male birds I shot, but one possessed the full per-

fection of plumage of the fourth spring, as mentioned by him, having the deep chestnut color covering the whole lower parts, and the glossy blackness on the head, wings and tail feathers; the others were birds of the second or third years. The nests I found, were *all* formed entirely of grass, coarse without and finer within, like those Audubon speaks of as usually built in Lŏuisiana.

On the 30th of July, I observed a number of these birds, not less than twenty-five or thirty, congregated together on the top of a decayed tree, which stood near the edges of a large cultivated field; at my approach they flew off, and since that time I have neither seen or heard a single individual of this species, and they seem to have entirely disappeared from the place, although the autumn is near at hand. — H. S. Kedney.

Tulip Trees Destroyed by Bark Lice. — I send you some specimens of Coccidæ belonging to the genus Lecanium, and which I think is an undescribed species.

Mr. P. R. Uhler of Baltimore writes me that it is new to him, and undescribed in the many works which he possesses treating of the Coccidæ. It is very near to the *Lecanium juglandis* Bouché.

I send you some of the deserted scales, also some of the larvæ as they appear at this date. These bark lice are very destructive to the Tulip tree (*Liriodendron tulipifera*). We had some beautiful specimens of these on the college grounds, which have been entirely ruined.

These insects are ovoviviparous. The eggs, which are one-fortieth of an inch in length, appear in July almost filling the female. In August the gravid female contains the embryo in all stages of development, from the undeveloped egg to the active larva. From the last of August to the first of October, the larvæ leave the scale through a central opening in the under surface.

The larvæ are in form and color quite like the common sow-bug, one-twenty-fifth of an inch long, antennæ eight-jointed, abdomen nine-jointed, the posterior joints being deeply sinuate, with a long seta on each side. After wandering about the tree from eight to ten days, they become attached to the bark of the trunk and limbs by little peripheral filaments, two on each segment. The color soon turns from brown to black.

The imago is perfectly formed in June. The turtle-shaped scale being then five-twentieths of an inch long, of a dark flesh color,

from which there exudes a sweet fluid which attracts swarms of flies (Diptera), bees and wasps, and falling on the leaves, forms a dark sticky wax. On the underside of the fully formed adult females are four cottony lines extending from the angles to the centre. In October the emptied scales fall from the trees.

The rate of increase is enormous, each female producing thousands of young. Two or three years are sufficient to destroy a large, vigorous tree. — A. J. Cook, *Agricultural College, Lansing, Mich.*

Instinct or Reason in the Robin?— A pair of Robins (*Turdus migratorius*) had, for three years, built their nests and reared their young on the trees in front of my house. The fourth year they decided for family ends to change the trees for the beams of of a new shed. There they built their nest; and soon four eggs were seen in it; in due time the young appeared. As they were in plain view from our window, and were also exposed to danger from boys, cats, and other enemies, we watched them very closely. After a few days, the birds had grown too large for all to remain in the nest, and one was seen on the beam outside. As cats were whetting their appetites looking at it, I determined to protect it at all hazards, and went near to watch. The parents seemed as fearful and anxious as I, keeping both of them on the wing, going to and from the nest, with much flutter, and noise and talk. I noticed they were bringing, what seemed to be nest material, in addition to the food for the young. The next morning at daylight a new nest close beside the old one, was completed, and two of the young placed in it. Here two in one, and two in the other nest, they were cared for until they could fly. The next year they began their family duties near the same spot, but a fearful gale blew down the shed, with its nest, eggs and birds and they have never nested on the place since.— Rev. S. A. L. Drew, *South Royalton, Vt.*

Laboratory for Marine Zoology.— Dr. Anton Dohrn in a letter to Professor Agassiz, who has communicated it for publication in this journal, writes that he has matured a plan which has for many years been in the minds of many zoologists; that of establishing a large laboratory for marine zoology in the Mediterranean. He has obtained permission of the authorities of the city of Naples to construct a large building at his own expense, in the Villa Reale at Naples close to the sea, containing a large aquarium for

the public, and extensive rooms for naturalists of every country. Dr. Dohrn, with two or three other German zoologists, will settle there and conduct the administration of both the aquarium and the laboratories. He wishes that information regarding this proposed laboratory be widely extended in America, and earnestly invites all who may go to Naples to visit the aquarium. An annual report of the work done and progress made at the zoological station will be published. A committee has already been formed to give farther dignity and importance to the project, consisting of Messrs. Hemholtz, Dubois-Reymond, Huxley, Darwin, Hæckel, Leuckart, Van Beneden, etc., and in this country Professor Agassiz.

Hybrids.—[Simply remarking that we strongly suspected that the supposed hybrid between the cat and raccoon was nothing more than a cross between an Angola and a common gray cat; a variety that is well known in this vicinity and in every way corresponding to the description given; and that we thought it best to let the communication printed in the October number call forth comments on this oft recurring question of hybrids; we accordingly give the following careful summary of the subject with thanks to Dr. Gill for treating it in so concise a manner.—Eds.]

To the Editors of The Naturalist.—I find in the number of "The Naturalist" for October (p. 660) which has just come to hand, a notice by Col. Higginson, endorsed by Prof. Jenks, of an alleged hybrid between a raccoon and cat, which is extremely tantalizing. No information as to the structural characteristics of the animal is given, and scarcely any as to other points, and yet it is not too much to say that the authentication of such hybridity would revolutionize physiology, for certainly nothing like it has hitherto been made known. Remarkable as is the hybridity of the ram and doe roe-buck (*Capreolus Europeus*) recorded by Hellenius, it pales into insignificance when compared with hybridity between the cat and raccoon. We have, in the last mentioned animals, not only representatives of distinct genera and families, but of *primary groups* (Superfamilies) of the fissipede carnivores, characterized by differences of as great morphological value, as, for example, those between the horse and rhinoceros: those differences, in the animals in question, are exhibited especially in the osseous, digestive, and generative systems, and it is therefore desirable to

know in what manner these systems are modified in the supposed hybrid; the living animal could readily be examined as to its dentition (the number of the molar teeth and their characteristics), the feet (whether digitigrade or plantigrade and whether tetradactyle or pentadactyle), the head (whether abbreviated and cat-like, reflecting the diminished number of teeth, or whether prolonged into an attenuated muzzle), and especially the character of the snout, whiskers, the claws, the tail and the pelage. The very vague information that has been furnished respecting the form, walk, tail and pelage is very insufficient, and conveys no clear idea as to the animal's peculiarities. No clear idea, either, is obtained by the mere reader from the statement that "the animal when taken up by the tail, turned upon the aggressor with a fury far beyond that of a common cat." Although my experience with cats under such conditions has been limited, I cannot conceive how more fury can be manifested than I have seen exhibited by one cat when subjected to such an interesting experiment. A clue is indeed furnished by the opening paragraph of Col. Higginson's remarks, namely, that the animal "struck [him] at first as being the handsomest *cat* [he] had ever beheld," and after this significant admission, it is more than probable that its characters would only require to be contrasted with those of an ordinary cat. It may be added that the wild cat (*Lynx rufus*) has "pointed and tufted ears" (which the raccoon has not) and hybridity between a domestic cat and lynx would not be improbable.* My acquaintance with you, Messrs. Editors, assures me that you must have entertained considerable doubt respecting the reliability of such an account, although you have made no comments, and you would confer a boon on science if you would procure a *photograph*—not a drawing which might reflect, unintentionally, the imagination of the artist—of the animal in question. Until better evidence than has yet been brought forward is offered, naturalists will not only be excused for doubting any such hybridity, but would be inexcusable for *not* doubting it, and you gentlemen will, I doubt not, concur in this sentiment. I scarcely need remind you of the physical difficulty a male raccoon and

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Of course, no reflection is cast upon the eminent gentlemen who published the account of the remarkable animal, and who have only repeated what they heard; they, probably not being very familiar with the order of mammals in question, naturally believed in and reflected the opinions of others. My only object in this communication is to elicit more evidence while it may readily be obtained, and I may be allowed to express the hope that when the animal — happily for the interest of science! — dies, it may be reserved for a more worthy fate than to leave its skin stuffed for a museum: it should, of course, be submitted to the examination of a critical anatomist.

In conclusion, a few words respecting the nature of the evidence required in alleged cases of hybridity may be serviceable. In view of the constant statements respecting hybrids circulated in various publications, affirmations and beliefs are not sufficient. Hybrids partake of characters peculiar to each parent, but modified by the sex of each parent. Therefore, all the men of China, Me., might swear they saw a cat and raccoon *in coitu* (and in view of the strength of the sexual instinct, the allegation might not be wholly incredible), and all the men of Taunton might swear that they believed that the offspring of one of the animals was the result of such amours (and in view of the credulity of man and the general ignorance respecting nature, the *reality* of such *belief* would be quite credible!) but all such affirmations and beliefs would not meet the requisites of the case, *unless* the offspring shared characteristics of each parent, and even if it were further sworn that the female had been precluded from intercourse with another animal, it would be no further evidence, for unless the allegation was confirmed by the characteristics of the animal, we would still have infallible nature against truthful and at least fallible man. — Theodore Gill.

GEOLOGY.

Geology of the Phosphate Beds of South Carolina. — Dr.

A. S. Packard, Jr., made some remarks on the geology of the phosphate beds of South Carolina. During a recent visit to Charleston, he had observed the phosphate diggings on the Ashley river, and at a locality on the northeast railroad eight miles from Charleston, but through the courtesy of C. C. Coe, Esq., Superintendent of the Marine and River Phosphate Mining and Manufacturing Company, and Dr. C. U. Shepard, Jr., he had enjoyed special facilities for studying the Quaternary, or Post Pliocene formation in which the phosphate bed occurs, having made two excursions in company with these gentlemen on the Company's steamer Gazelle. He was also indebted to Prof. C. U. Shepard, Sr., for much valuable information regarding the chemical as well as geological history of these interesting beds. Analogous beds have been discovered in the later tertiary of England near Cambridge, but they are becoming exhausted, and manufacturers of superphosphates are now importing large quantities of the crude phosphate rock from Charleston, S. C., as well as the phosphate, or apatite, rock from the Laurentian formation of Canada, which Dr. T. Sterry Hunt, the distinguished chemist of the Canadian Geological Survey, believes to have resulted largely from the decomposition of shells, especially those of Lingula.

The phosphate beds of South Carolina are spread over an area along the coast one hundred miles along, and about twenty miles in breadth; the formation is not continuous, being sometimes, as stated (in conversation) by Prof. C. U. Shepard, Jr., replaced by ferruginous sand. It has already been largely used as a fertilizer for worn out lands of the Sea Island cotton region, and promises from the unlimited supply of the rock, to become a large industrial interest of the state, six million dollars having already been invested in lands and mining and manufacturing materials by northern capitalists alone.

The relation of the phosphate beds to the Quaternary formation of the state and of the latter to the glacial beds of sand and clay of the northern states, were, however, the principal points he would allude to. At a celebrated locality of Quaternary fossils at Simmon's Bluff on Wadmalaw Sound, about thirty miles by steam from Charleston, he made with the kind and generous aid of Dr. Shepard, Jr., a large collection of fossils, from a bed of sand and mud about four feet in thickness. This bed corresponded with the marine clays of New England and Labrador, and the ancient sea

bottom with its multitude of shells, which remained just as they had died in their holes, reminded him of an ancient raised sea-bottom at Hopedale, Labrador.

These clay beds graduated into clay and sand, containing a ferruginous layer, supposed by Dr. Shepard, Jr., to be the horizon of the phosphate beds. These beds correspond to the beds of clay at Gardiner, Maine, where Sir Charles Lyell discovered the bones of the Bison and Walrus. They contain bones of the Megalonyx, Mastodon, Elephant, Tapir, two species of Horse, Peccary, Rhinoceros and Manatee. The sands graduate into the beach sands of the close of the Quaternary, just as do the Bison and Walrus beds of the Kennebec river. The phosphate beds, then, were probably rolled masses of Eocene rock crowded with shells, mingled with the bones of the animals above mentioned, deposited and arranged by the waves of a shallow sea a few feet deep. This sea was much shallower even than that which covered the ancient sea bottom beneath, which must have been only from one to five or ten fathoms deep, as the same shells are at the present day thrown up on the neighboring beaches in great abundance, and he had dredged some of them at a depth of from five to thirty feet at Beaufort, N. C.

After their deposition, the carbonate of lime of the shell marl of the Eocene rocks had been replaced by phosphate of lime. How this had been effected, and whence the phosphate of lime was derived, was a question still unsettled by chemists. He alluded to the theory of Prof. Shaler that this phosphate deposit had been formed at the bottom of the Gulf Stream, which, according to that geologist, had probably flowed over the site of the present phosphate beds; and in opposing the theory suggested that the phosphate beds were deposited in shallow water, perhaps lagoons as suggested by Prof. Holmes, as they rested in a shallow water deposit above alluded to. There was no apparent evidence, as well shown by the facts published by Tuomey in his geological survey of South Carolina, of a depression of the coast. On the other hand there is no apparent evidence of glacial action on the coast, since the Quaternary sands are marine or aerial, and Tuomey states that he has nowhere in the state of South Carolina seen any angular blocks, nor a pebble a foot in diameter. Moreover, the life of the Quaternary in this state indicated even a warmer climate than at present obtains.

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the paper by Desor, than whom no one can speak with greater authority, in which he has made a comparison* between the glacial marine beds of the North and the marine coast deposits of the Southern states, parallelizing the deposits in a masterly manner. His remarks entirely confirm the views given above. One difficulty Desor had in parallelizing the Laurentian beds of the North with those of the South containing the remains of land animals, was the apparent absence of the remains of land animals in the clays of the North, but since then teeth of the bison have been found at Gardiner, Maine, in the upper part of the clays. It may also result from farther investigation that the phosphate beds were laid down at a later period than we have supposed; at the time when the great mammals found in the cave at Phœnixville by Mr. Wheatley flourished, perhaps during the earlier portion of the river terrace period when the mammoth and mastodon lived both in the northern and southern states.

Thus, the parallelism between the Quaternary beds North and South would seem to be even more exact than Desor twenty years ago could make it with his data. The climate gradually grew warmer from Labrador to Florida; the Gulf Stream did not apparently change its bed during the Quaternary period; the oscillations of level of the coast of South Carolina were slight and involved but a few feet, where in Canada and Labrador the rise and fall involved several hundreds; and the denudation effected in the North by land ice, was caused in the South by oceanic currents, waves and atmospheric agencies. There are apparently no facts to show that while the glaciers lined the coast of New England, the waters of South Carolina were not as warm, if not warmer, than at the present day, from the effects of the Gulf Stream. — *Bulletin Essex Institute.*

Deep Sea Explorations. — The expedition by the Coast Survey, under the charge of Professor Agassiz and Count Pourtales, to explore the sea at great depths in the Southern Atlantic and along the Pacific coast, revives the interest in the remarkable discoveries made by the late English deep-sea dredging explorations in the Mediterranean Sea. It seems, as "Nature" remarks, that Humboldt, as long ago as 1812, maintained that

* Post Pliocene of the Southern states and its relation to the Laurentian of the North and the deposits of the valley of the Mississippi. By E. Desor. American Journal Science and Arts. 1852. Vol. 14. p. 49.

such a low temperature exists at great depths in tropical seas as can only be accounted for by the hypothesis of undercurrents from the Poles to the Equator. The temperature soundings taken on the last English expedition show that the bottom of the sea off Portugal, below one thousand fathoms, ranges from thirty-nine to thirty-five degrees, or about the freezing point. In the Mediterranean the temperature beneath the hot surface stratum of water is uniform to any depth — namely, about fifty-five degrees. It is naturally inferred that in the Atlantic and Pacific oceans an undercurrent of polar icy water is flowing southward under the warmer tropical waters; and this is sustained by the discovery at great depths of polar animals in the seas of Florida and Cuba. The English expedition under Professor Carpenter, the well known physiologist, has also detected the existence of an outward undercurrent in the Strait of Gibraltar, which carries back into the Atlantic the water of the Mediterranean that has undergone concentration by the excess of evaporation in its basin. Professor Carpenter confirms the theory previously urged by Captain Maury, that the cause of the superficial in-current and the deep out-current is to be found in the excess of evaporation, the Mediterranean water being from evaporation denser than the water of the Atlantic. Carpenter then compares the polar and equatorial areas, and shows that there is a tendency in the former to a lowering of level and increase of density, which places it in the same relation to the latter as the Mediterranean bears to the Atlantic.

Coal Beds in Panama. — In a paper read before the Geological Section of the British Association, Dr. Hume stated that, during a recent residence upon this isthmus, he learned that a series of seams of coal had been found in a secluded and primitive portion of the country, not far distant from the railway. He had procured and analyzed some specimens of the coal, and had found 75 per cent. of carbonaceous matter, the balance being water and ash, and a very small quantity of sulphur. The coal possessed a fair heating and large illuminating power.

MICROSCOPY.

Angular Aperture. — An anonymous querist in the "Monthly Microscopical Journal," incidentally to asking the aperture of a certain lens, urges the importance of angular aperture as an ele-

ment in the construction and study of objectives, and intimates, which is hardly saying too much, that the peculiar qualities of the objectives depend more on their angular aperture than on their focal lengths. "Focus and aperture are in fact both essential factors in the denomination of an object-glass, and where a difference exists in either we must keep in mind that we are comparing different things, and not the same things with differing qualities." The estimation of any angular aperture, so well expressed by "B," is perfectly familiar and undisputed among experienced microscopists, although its exact bearings are not always easily apprehended by beginners; and that microscopists need occasional caution in regard to it may be inferred from the case in point, where an accomplished writer stated an extraordinary performance of a lens, without mentioning the range of its apertures or the aperture at which he worked it. The peculiar and entirely independent qualities of lenses of low and of high angles are everywhere understood alike; but the extent to which success has been attained in this country in the construction of high angles cannot be appreciated abroad when "B," evidently well informed on other points, would not be surprised to hear that a one-fifth of excessive resolving power had an angular aperture of 150° or 160°. Any one in this country would be "surprised" to hear that its highest angle was less than 170°.

Makers should always engrave the angular aperture upon the mounting and on the boxes of their objectives. The neatness and sufficiency of this plan, however, is marred in the case of many modern objectives whose screw-collar adjustment gives a wide range of powers and angles. Exactly at what point of adjustment the measurements should be made in these cases is one of the most difficult points to be settled in endeavoring to obtain a uniform nomenclature in regard to the works of different makers. At least for the present, until some standard degree of adjustment can be agreed upon, both the highest and lowest figures should be given where the range is considerable.

Passage of Corpuscles Through the Blood-vessels. — The "Monthly Microscopical Journal" reviews a paper on the subject read before the Royal Society by Dr. R. Norris. Previous hypotheses fall short in regard to the most singular and important part of the process. The question is less how the corpuscles get

out, than how they get out without leaving any trace of their passage through the wall. Observers are agreed that both red and white corpuscles pass out of the vessels through apertures which, manifest during the period of transit, can be seen neither before nor after that time, and that it is essential to the process that the corpuscles shall cohere to the wall of the vessel and shall be subsequently subjected to pressure from within. The physical conditions essential to the passage of a rigid body through a colloid film, as when a solid body passes through a soap-bubble without breaking it, are present in the case of the minute blood-vessels and the corpuscle, and are as follows;—an intimate power of cohesion, either mediately or immediately, between the film and the body, a certain amount of pressure from within, and cohesive plasticity of the substance of the film so that the breach in it may become united as it descends upon the opposite surface of the body which is being extruded.

Cutting and Staining Tissues.—Mr. E. Ray Lankaster recommends, in the "Quarterly Journal of Microscopical Science," that a small piece of tissue be enclosed in a metal box and frozen by means of a freezing mixture. It is then held between pieces of pith in wooden forceps (or an American clothes-peg) while sections are cut by a razor cooled in snow, the cutting being performed in a cold room. Three razors are used that two may be cooled while one is used. The sections are first placed in a one-half per cent. gold chloride solution, or in silver nitrate solution if desired. After five to seven minutes they are transferred to distilled water and soaked for a few hours. They are then placed in water acidulated with lactic acid to reduce the gold chloride, and after the red-violet color is fully developed they are teased out, if necessary, and mounted in glycerine.

Adulteration of Tea and Coffee.—According to Dr. Hector Helshan's paper on the employment of the Microscope in analysis, before the South London Microscopical and Natural History club, coffee drinkers are liable to be treated to a decoction of roasted coffee-berries, chicory, poor flour, stale sea-biscuit, tan-yard refuse, peas, beans, and saw-dust. Some of these modern improvements may be escaped by buying the coffee unground. Dainty tea-drinkers will notice with interest that the Chinese export teas rendered attractive by the salts of copper, lead, and iron,

and cheapened by mixture with the refuse tea-leaves from the kitchens. Other leaves are largely prepared and sold as tea, and the process of improvement is further carried on by the importers at home. Willow leaves have been much substituted for tea, and have been said to be a good substitute.

ANOTHER ERECTOR. — A flat minor above the eye-piece was exhibited by Mr. E. Richards, as an erector for the microscope, at the October meeting of the Royal Microscopical Society. He uses a glass plate platinized in front. This little erector is cheap and easily used when the microscope is in a vertical position. It is not, however, easily applicable in an inclined position of the instrument; and it is liable to narrow the field of view. This is a modification and adaptation of Mr. E. T. Newton's apparatus published in the "Quarterly Journal of Microscopical Science," July, 1871.

AMERICAN MICROSCOPICAL SOCIETY OF THE CITY OF NEW YORK. — Rooms: Mott Memorial Building, 64 Madison Av., New York. Officers: *President*, F. A. P. Barnard, S.T.D., LL.D.; *First Vice President*, J. E. Gavit; *Second Vice President*, H. G. Piffard, M.D; *Recording Secretary*, J. W. S. Arnold, A.M., M.D.; *Corresponding Secretary*, R. A. Williams, Jr., A.M.; *Treasurer*, E. C. Bogert; *Curator*, Samuel Jackson; *Librarian*, J. H. Cornell; *Trustees*, T. F. Harrison, C. Van Bunt, W. H. Atkinson, M.D., D.D.S., S. G. Perry, D.D.S., D. H. Goodwillie, M.D., D.D.S. — *The Medical Record.*

IMPROVED APPARATUS FOR DRAWING WITH THE MICROSCOPE. — Mr. E. T. Newton proposes, for microscopical drawing, a steel reflector partially covering the eye-lens and mounted with a provision for rotation, so as to be easily adjusted to use with the instrument inclined at any angle. The Beale neutral-tint reflector, etc., should be mounted, for those who prefer to use it, with a similar rotating movement. This substitute for the camera has the additional advantage of being an erecting arrangement.

MICRO-SPECTROSCOPE. — Mr. H. G. Bridge states in the "Monthly Microscopical Journal" that it is perfectly feasible, with Mr. Browning's bright-line micrometer, to record or map the spectra observed, so that the positions given shall be correct to the unit of the micrometer circle.

PROTOPLASMIC LIFE.— Mr. Crace-Calvert stated that life will become manifest in the albumen of a fresh egg mixed with pure water after an exposure of fifteen minutes to the atmosphere. Experiments in spontaneous generation are often vitiated by momentary exposure to the air.

NOTES.

PROF. Agassiz has published a letter in regard to the expedition in the Hassler, in which, after stating that some published statements are incorrect in many particulars, he says: —

"The Hassler was built for the coast survey work of the Pacific shore of the United States. Any work undertaken on board this vessel, is, therefore, entirely subordinate to that of the regular operations of the survey. As she must, however, necessarily make the tour of the South American continent, in order to reach her destination, Professor Pierce, the Superintendent of the Coast Survey, has thought it wise to organize a scientific party, consisting of men who might render the voyage in the highest degree useful to science, as well as to the special interests of the survey itself. To this end he has provided a dredging apparatus in connection with the hydrographic operations, thus continuing on a larger scale the work so admirably conducted under his auspices in the Gulf of Mexico during the last five years. The wider range thus given to these operations will, of course, greatly enhance the value of the previous work, and lay the foundation for much more effective researches in the future.

I consider myself fortunate in being connected with this voyage, doubly so because the companions with whom I am associated are men of tried ability, some of them having a larger experience than my own in special details of the work, while Captain Johnson, commander of the Hassler, adds to his professional skill a zeal for the interests of science warmly shared by the officers under him. But while everything has been done to give this initiative voyage of the Hassler a high scientific character, it must not be forgotten that the present expedition is simply an incident in her history. The superintendent has indeed allowed me to make collections on our way, since we sail in waters where everything that lives has special value for the naturalist; but the expense of making these collections, and indeed all expenses of the scientific party not directly connected with the Coast Survey work, will be paid from private means provided by individual liberality.

I have thought it best to publish this statement in order to make it fully understood that the scientific expedition connected with this voyage is not its chief object, except so far as that expedition subserves the best interests of the Coast Survey."

The vessel sailed December fourth, and will touch first at St. Thomas Island. The steamer burns less than three tons of coal a day, and can thus run eight thousand miles on one hundred and fifty tons of coal, a remarkable saving of fuel. Professor Agassiz has taken out abundant stores for preserving specimens, and deep sea nets and hooks specially adapted for catching fish at great depths. We also publish a letter to Professor Pierce, the Superintendent of the Coast Survey, in regard to the aims of the dredging party from advanced proofs received from Professor Pierce, and published as a Bulletin of the Museum of Comparative Zoology.

We noticed in the last number of the Naturalist the instruction in science afforded to the teachers of Boston at the Hall of the Natural History Society, the means having been furnished by Mr. John Cummings; we should not forget the other efforts made to instruct the public and popularize science, under the auspices of the same vigorous institution, the means of which have been and are this year to be furnished by Mr. John A. Lowell, as trustee of the Lowell Institute Fund. The first courses were given for a nominal price of admission in the lecture-room of the Society's Museum, last year. The following is the programme of the lectures for this season:

"First course, beginning October 23, twelve lectures on Popular Geology by W. T. Brigham, A.M. Subjects—'Water as a Geological Agent; Chemical and Physical Properties of Water; Dew and Rains; Springs; Rivers; Waterfalls; Bogs and Marshes; Lacustine and Oceanic Deposits; The Ocean; Caverns; Snow and Ice; Glaciers; Deluges.'

Second Course, beginning December 4, six lectures by B. Joy Jeffries, M.D. Subject—'Comparative Anatomy of the Eye, and Vision.'

Third Course, beginning December 26, ten lectures by Professor G. L. Goodale, of Bowdoin College. Subject—'Physiological Botany, a study of some of the relations of Plants to Heat, Light, Electricity and Chemistry.'

Fourth Course, beginning January 29, six lectures by Thomas Dwight, Jr., M.D., Subject—'Preservation of Life among the Vertebrates.'

Fifth Course, beginning February 19, six lectures by W. G. Farlow, M. D. Subject—'Cryptogamic Botany, with special reference to the Algæ.'

Sixth Course, beginning March 11, by F. G. Sanborn, Subject,—'Talks about Insects.'"